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NOTICE TO AUTHORS OF PAPERS

1. Forwarding Address. Papers intended for publication in THIS JOURNAL should be submitted to Neil E. Gordon, Editor, The Johns Hopkins University, Baltimore, Maryland.

2. Manuscript. The manuscript submitted should be an original (not a carbon) copy, and typewritten, double-spaced, with 2–3 cm. margins. The title of the article should be followed by the name and address of the author. If the paper has been presented at a meeting, a footnote giving name of society, date, and occasion should immediately follow the author's name. The usual editorial customs, as exemplified in the most recent issues of the JOURNAL, should be followed as closely as possible.

3. References and Footnotes. Each reference to the literature and each footnote should be inserted without a number, as a separate line (or lines) immediately following the word to which it refers in the text. A reference to literature should include, in the order named, the title of book or article, author's name, edition or volume, pages, date of publication, and, in the case of books, publisher's name.

4. Illustrations. Not all articles lend themselves to illustrations, but articles which do should be accompanied by as many pertinent illustrations as possible. As a rule, apparatus, particularly if complicated, is best presented by means of line or working drawings. Photographs are sometimes sufficient, however. When both can be obtained, it is generally desirable to include both.

Photographs should have a gloss finish and should be at least post-card size—larger, if possible. Only prints which are unblurred and which show sharp contrast between light and dark areas can be satisfactorily reproduced.

Line drawings should be carefully prepared in black ink on plain white drawing paper or blue drawing cloth, twice or three times the size desired in the printed cut; it is convenient, when permitted by the scale required, to have them the size of the manuscript. When coördinate paper is used, it should be printed in blue only, with the important coördinate lines ruled over in black; the black square should in general not be less than ten millimeters on a side; the lines of the curves should be the heaviest, except the frame; points on the curves should be indicated by true circles, not crosses. The numbering of the coördinate axes, the number of the figure and any necessary explanations of the figure should be written in pencil in the margin of the sheet, as they are usually set up in type rather than reproduced from the drawing. All lines, numbers, and letters that are to be reproduced are to be so proportioned that they will be clearly legible in the cut.

Tables should be inserted in the body of the manuscript at the proper place.

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Adolf Baeyer

EDITOR'S OUTLOOK

THAT the scientific spirit, though capable of intensive and extensive cultivation, must strike its roots in personality, is the immediate inference from a perusal of the career of the great organic chemist who is the subject of this frontispiece. Johann Friedrich Wilhelm Adolph Baeyer was born in Berlin in 1835, the son of an officer in the Prussian army. Growing up in a home of military and legal traditions, in which foregathered the historical and literary lions of the day, the boy seemed rather the heir of those great teachers and investigators who, during the first quarter of the 19th century, had given new life and meaning to the name of science. Even in his childhood, Adolph Baeyer proved that in the atmosphere of science he breathed his native air. At the age of twelve, his overflowing curiosity and activity in chemical experimentation was a source of such concern to his family that his father, in that discretion which is so often the better part of parental valor, set up a diminutive laboratory for him, with a popular chemistry text for guide.

Adolph Baeyer, 1835–1917

Launched thus early on the career that was destined to produce revolutionary effects in his field, he had the good fortune to begin his formal scientific training under excellent teachers. During his adolescence, botany and geology, physics and mathematics, in turn engaged his primary interests. His earlier affection for chemistry, however, finally determined his vocation and led him to the famous laboratory of Bunsen at Heidelberg, where, after a period of only six months, the industrious application of his previous training earned him the privilege of beginning original work in assisting Bunsen and Roscoe in their experiments with chlorine and hydrogen under the influence of light. Thus in 1857 Baeyer's name appeared over a scientific paper, the first of a series of publications that were to record the indefatigable and almost uninterrupted endeavor of more than half a century. A short time later, he became the first pupil in the private laboratory of Kekulé, under whom he worked at Heidelberg and at Ghent.

Baeyer's first independent activity as a teacher and experimenter began in Berlin, where, in 1860, he accepted an appointment as instructor in inorganic chemistry in the Gewerbe-Institut. It was an inconspicuous and ill-remunerated post but surely not without its personal compensation to the young man who here established, in conjunction with the capable and earnest assistants whom he attracted to it, a school of research from which issued the synthesis of alizarin from coal-tar anthracene, the basis of the German dyestuffs industry.

Through the medium of these and other brilliant investigations in the laboratory in the Klosterstrasse, fame found him out. The call to a

professorial chair, with its prospect of organizing a school of chemistry, met with his acceptance and in 1872 Baeyer joined the staff of eminent men who then composed the scientific faculty at Strassburg. His stay, however, was brief and, although his researches continued (in conjunction with a new disciple, Emil Fischer), they were so punctuated by the distractions incident to new construction at the university that the period was more or less an interlude in his scientific life.

In 1875 Baeyer was honored by the invitation to succeed Liebig in the chair of chemistry at Munich. It is recorded that he accepted with reluctance and only at the solicitation of his friends the post at which he was to spend forty years of prolific labor. Here in the establishment of a school of practical chemistry abandoned under Liebig, he took up the work of establishing sound fundamental training in the elements of chemistry, an object of such importance in his eyes that he handled these classes himself throughout his career at Munich and surrendered them only with the surrender of his post. Here he resumed his work on indigo, completing what one of his most successful pupils, William Henry Perkin, declared to be "those marvelous syntheses which are the wonder of every chemist who repeats them." Here, at an age when other men look to rest from their life-work, he turned to new fields of research and with an unflagging mental vigor sent out from his school a stream of publications, whose remarkable extent and variety can only be accounted for by the fact that throughout these years he held to the even tenor of his way as an educator and investigator, resisting with equal tenacity the encroachment of administrative demands on the one hand and of industrial pressure on the other. In 1904 the award of the Nobel Prize, in recognition of his services in the development of organic chemistry and the chemical industry through his work on organic dyes and hydro-aromatic combinations, spread throughout the world the renown which he had long since attained in his own sphere. It was not until the war invaded his official family and deprived him of the capable assistance which had supported his eminent labors that the old man voluntarily gave up his duties. He died in 1917, surviving his retirement only by two years.

Perkin indicates the motive force which was responsible for the accomplishments and reputation of his school. "There was a feeling in the laboratory that no one was of any account who did not research and moreover the position of each researcher and the esteem in which he was held depended solely on the quality of the work he was engaged in. This was the atmosphere which produced the greatest chemists of the day and weeded out those who were of no account. It was only necessary that the commanding figure of Baeyer should stroll through the laboratory each day and for him to chat with the various workers, criticize their results, and admire their preparations, to make it out of the ques-

tion for any one to forget for a moment that research was the only thing that really mattered."

The JOURNAL gratefully acknowledges its indebtedness to Mr. Sederholm, the managing director of Nobelstiftelsen, Stockholm, Sweden, for the accompanying picture.

The Handmaid of the Sciences

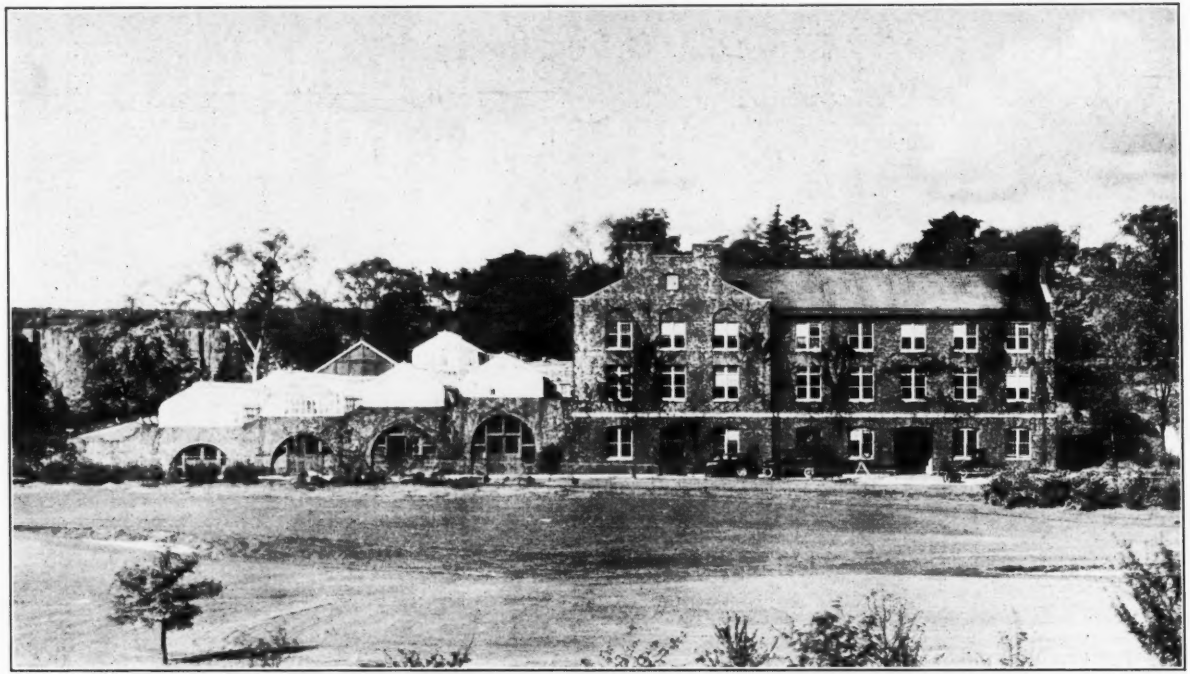
SO LONG ago as 1905 the late Dr. Hillebrand deplored the standards which prevailed in the teaching of analytical chemistry. In 1916 he regretted that he had been able to note but few signs of general improvement in the intervening period. Last year many of the speakers who contributed to the symposium on the teaching of analytical chemistry of the Division of Chemical Education expressed themselves as somewhat less than altogether content with the present status of analytical instruction.

The consensus of opinion seems to be that analytical chemistry has been too useful for its own good. We have so long looked upon it as a helpful tool in the other branches of chemistry that we have forgotten that it can and should be a fruitful field of study and research in itself—a field in which other branches of chemistry may in their turn assume the rôles of useful tools. As some one else has expressed it, it is time that the handmaid of the sciences be invited to a place at the family table.

Among those who have realized the need for intensive research in analytical chemistry is the J. T. Baker Chemical Company. For several years the company has supported research fellowships with this aim in mind. A separate branch department has now been established within the research organization of the company to pursue pure research in analytical chemistry. The importance attached to the new departure may be gaged by the fact that the director of analytical work occupies a position on a par with those of the other administrative heads of the company.

Dr. John F. Ross, recently of the research staff of the Eastman Kodak Company, has been chosen to head the new department. He comes to his new task with a background of thorough training and of extensive experience. Already his name has been associated with considerable research of recognized caliber in analytical chemistry.

We trust that the new project may bear fruit which will attract other organizations to cultivate the same field.



BOYCE THOMPSON INSTITUTE FOR PLANT RESEARCH, INC., YONKERS, NEW YORK—EAST ELEVATION

This Institute was completed and dedicated in the fall of 1924. Plans are now under way for the erection of new buildings to be completed sometime in 1930, costing about $400,000, more than doubling the total space of the present laboratories, and providing an administration building and library. This building program has been necessitated by the actual growth of the Institute's work.

THE BOYCE THOMPSON INSTITUTE FOR PLANT RESEARCH, INC.

P. W. ZIMMERMAN, BOYCE THOMPSON INSTITUTE, INC., YONKERS, NEW YORK

At the request of your editor, Dr. Neil E. Gordon, who visited the Institute a short time ago, I shall attempt to give you a brief general statement of the purposes, equipment, and types of research at the Boyce Thompson Institute for Plant Research, Inc., at Yonkers, New York.

During the World War, Colonel W. B. Thompson became impressed by the great food shortage and the dependence of the whole population upon plants. He felt that a signal service could be rendered to humanity by fostering some scheme which would give a greater insight into the secrets of plants. New practices can be put into operation only as new facts are discovered. With the idea that the better the equipment and conditions for work, the greater the possibilities for uncovering facts, Colonel Thompson founded and equipped an institution differing from any other of its kind in the world. After the buildings were erected and the laboratories equipped, the institution was endowed to provide permanently for maintenance and new equipment. The doors were officially opened for work in September, 1924. Since that time, the endowment has been quadrupled and much new equipment added.

Harris and Ewing

COLONEL WILLIAM BOYCE THOMPSON

Impressed during the World War by the great food shortage and the dependence of the whole population upon plants, Colonel Thompson founded and endowed the Boyce Thompson Institute for Plant Research, Inc.

Purposes

Three main ideas were involved in building and organizing the Institute: (1) to secure the best possible equipment for the solution of plant problems; (2) to build up a coöperative staff of specialists representing many lines of technic necessary for attacking plant problems; (3) to attack practical

problems in a fundamental way so that the results of the work might contribute both to practice and to science.

Equipment

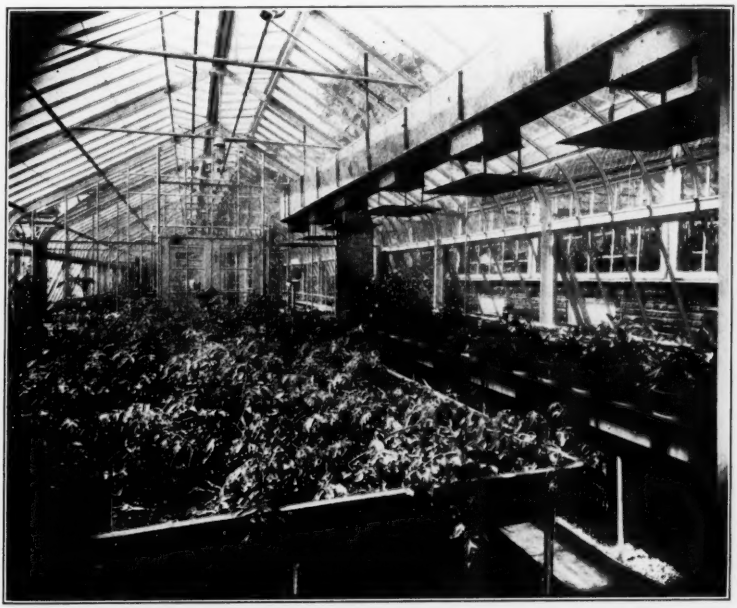
The present laboratory building represents one corner of a quadrangle of the future plant. The next step will be to erect an administration building which will also house the library and assembly hall and furnish additional laboratory space. The plans are now taking shape and the building should be completed some time in 1930. The present building was planned and equipped to meet unusual requirements for solving plant

BIOCHEMICAL LABORATORY
One of the laboratories equipped for solving plant problems.

problems. The growing of plants under controlled conditions is a specialty. Adjoining the building are 28 greenhouses furnishing a wide range of control conditions. These houses are equipped with controls for temperature, humidity, extra light, and extra carbon dioxide. The humidifier can be run so as to bring the air in the houses near the dew point. Extra carbon dioxide can be brought in from the flues as a by-product, the flue gas being scrubbed first by an especially constructed set of equipment to remove toxic substances. One set of five small houses is equipped with special glass which permits only certain rays of the sunlight to reach the plants. In one case only blue and green rays get through, and in another the red

and orange rays are admitted. By screening out certain rays it is possible to determine which are most effective for plant growth and reproduction.

A Koenig and Martin spectrophotometer is used for measuring the percentage of transmission of the visible region of light through glasses and solutions. The transmission of both the visible and ultra-violet through glasses or solutions is recorded photographically by a Hilger E3 quartz spectrograph. This apparatus also brings out the emission spectra of light sources. An underwater spark gap is used to emit a continuous



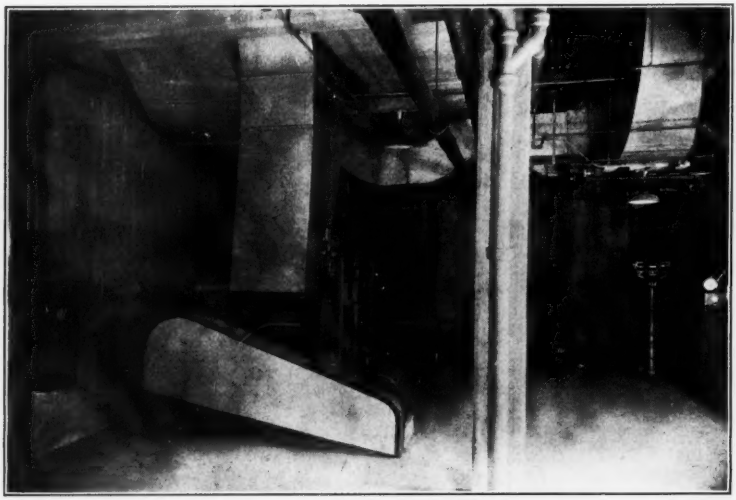
GREENHOUSES EQUIPPED FOR HUMIDITY CONTROL
Humidity is controlled to within two per cent and temperature to one degree.

spectrum in both the visible and the ultra-violet regions. At present one house is being equipped with glass which eliminates all ultra-red rays, and another with glass which transmits ultra-red only. What the effect will be on plant growth of such unusual conditions remains to be seen.

Two other notable pieces of equipment are the gantry light crane and the constant light and dark rooms. The crane, which can be moved over the greenhouses, is equipped with forty-eight 1000-watt lights for the purpose of supplementing daylight with artificial light at night. The constant light room is located in the basement away from natural sunlight, but

is equipped with twenty-five 1500-watt electric lights. The light intensity is great enough for plants to grow from seed to maturity without ever being subjected to sunlight. The adjoining dark room has all the conditions of the light room except the light. This makes possible the study of light duration as affecting plants. For example, tomato plants grow well if left for 19 hours in the light room and the remainder of the day in the dark room, but if left constantly in the light room, foliar injury occurs and growth is stopped. On the other hand, Salvia can grow well in constant light but it will not flower if the daily light duration is more than 15 hours.

Other pieces of notable equipment are a mercury vapor lamp for producing ultra-violet light beyond those rays possible from sunlight; an



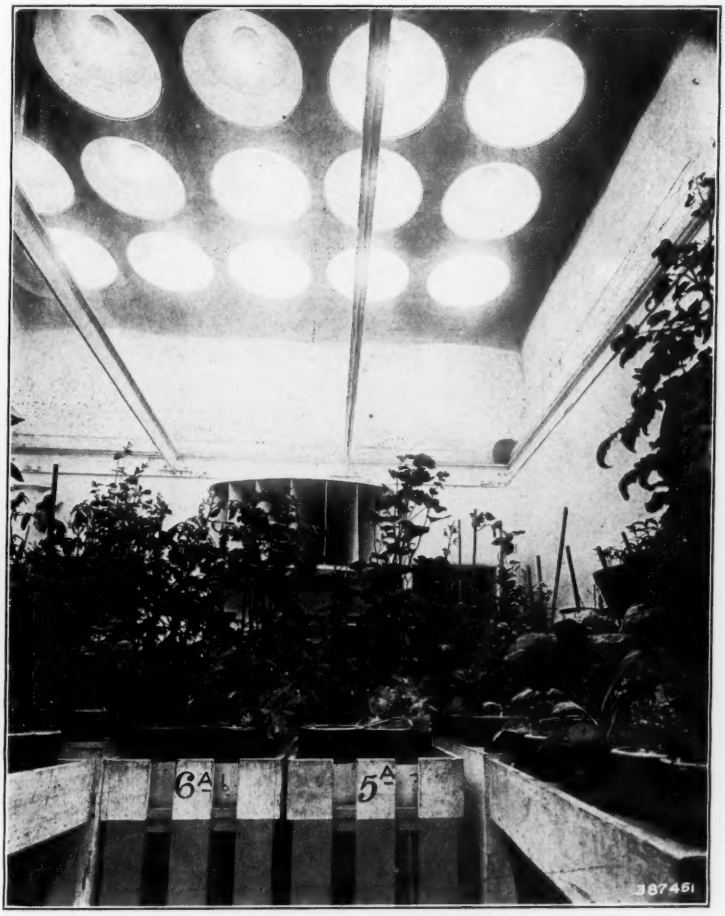
APPARATUS IN THE BASEMENT FOR CONTROLLING THE HUMIDITY IN THE GREENHOUSES

ultraphotomicrograph for detecting particles smaller than can be seen by the ordinary microscope; and photographic equipment for all sorts of work, including motion picture cameras for photographing living tissues while in action.

Five refrigeration rooms equipped to maintain constant low temperatures are valuable parts of the equipment. In one of these rooms which is maintained at —15°C., eight exact control chambers, equipped with automatic thermo-regulators, are kept for work that needs to be done within less than one-half degree variation in temperature.

The staff of the Institute has been chosen to represent the lines of technic and the fields of knowledge most needed in the solution of plant prob-

lems. Effective coöperative work is often necessary where a plant physiologist, a chemist, and a plant pathologist may need to attack a problem.



Photograph by John M. Arthur

INSIDE THE CONSTANT LIGHT ROOM

This view shows positions of lights above the plants and the ray filter beneath, consisting of a plate of glass over which water is continuously circulated. The plants may thus receive any day length of artificial illumination up to twenty-four hours.

By having all these different fields of science represented several types of technic can be centered on one problem. With this coöperative system it is

often possible to accomplish in a few months what would require years for a single specialist. The staff is made up of biochemists, plant physiologists, plant anatomists, physical chemists, entomologists, protozoölogists, plant pathologists, and microchemists. To these soon will be added plant breeders, physicists, and organic chemists. At present the Institute has about 37 scientific workers and 50 other employees. A coöperative system arranged with universities and colleges brings to the Institute each year several scientists who want to take advantage of special equipment and possibilities for doing plant research.

A coöperative group insurance, pension arrangement, is maintained whereby the employees pay for only a small part of the benefit, the Institute paying the remainder. The plan allows the employee to retire at the age of 65 with a pension in proportion to the years of service.

The property and endowment of the Institute is valued at approximately $12,000,000. All of the money to date has been contributed by Colonel William Boyce Thompson. Current expenses for some of the projects have, however, come from interested individuals or organizations. For example, an annual allotment of $20,000 comes to the Institute from the Frasch Fund for research in agricultural chemistry.

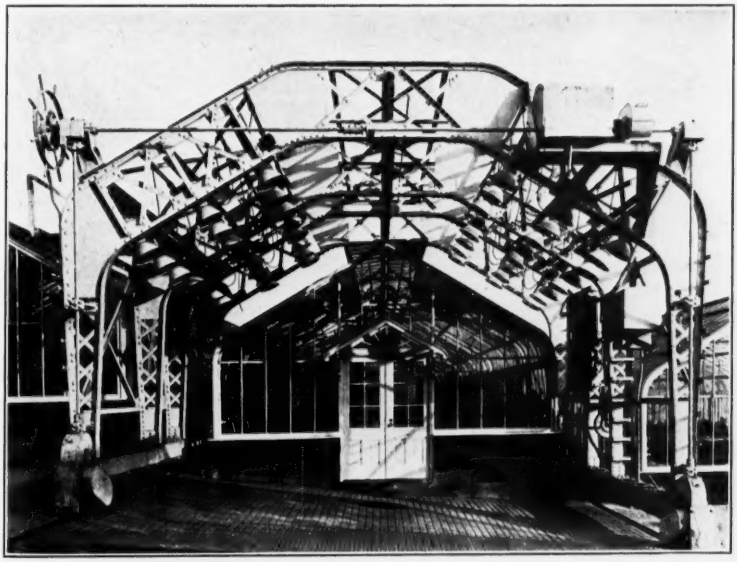
Types of Research

To illustrate the types of work undertaken by the Institute, mention will be made of a few problems now being investigated.

PLANT PROPAGATION

Plants are multiplied by means of seeds and by vegetative reproduction. Many of the desirable varieties, however, produce seeds which do not germinate when given all the known conditions favorable for growth, and the result is that the growers suffer a considerable economic loss. Many requests for help have come to the Institute from plant breeders and nurserymen. The difficulties were so involved that no specialist could sit down at his desk and solve the problems. It was necessary to subject the seeds to many different treatments under controlled conditions in order to determine what they needed to make them germinate. Such facts have been gathered for hundreds of species of plants. Chemical studies and correlations are now being made in an attempt to get at the underlying principles in seed germination. For example, *Cornus florida* seeds will not germinate if gathered from the tree and planted directly in moist soil at room temperature. If, however, they are planted in moist soil and then stored at 0° to 5°C. for 120 days, they germinate soon after being returned to the warm room. The problem is to determine what changes take place during this cold storage period and, if possible, to find a substitute for the cold treatment. Some progress is being made in this direction. The complex

situation is further complicated by the fact that seeds of different plants vary in their requirements. For example, in the rose genus, it is found that one species requires 60 to 80 days of cold treatment while another species needs 120 to 140 days. With such facts at hand, applications can be safely made. One of the main ideas held at the Institute is here realized, an attempt to attack practical plant problems in a fundamental way so that the results might contribute both to practice and to science.



GANTRY CRANE FOR ILLUMINATING GREENHOUSES

This crane carries 48 1000-watt lights and is electrically driven so it can be easily moved over the greenhouse at night and be removed in the day time. This crane enables the investigator to lengthen the daily period of natural illumination at will, with an intensity of light amounting to four or five hundred foot candles.

Referring again to vegetative reproduction, our fine hybrid ornamental plants must be propagated by means of cuttings or grafts because they do not come true to type when grown from seed. The problem in such cases is to find a way to make stem cuttings form roots. As with seeds, vegetative reproduction varies with the species, some responding with ease and others with difficulty. The factors involved in regeneration are being studied with the hope of learning something about the underlying principles governing root growth from cuttings. The results of the experiments to date have been useful in working out new methods for propagators as well as to help solve the general problems. The Institute is being called upon to solve

more commercial problems than it can undertake. As a consequence, its policy is to select from the numerous problems presented only those that promise progress in science and improvement in practice.

PLANT DISEASES

Many diseases of plants are being investigated at the Institute, but the most striking results have come from the work upon mosaic and yellows diseases. The latter will be used as an illustration. The yellows diseases have long been puzzling, and have received the attention of many plant pathologists. Peach yellows has been known for many years and has destroyed many orchards, and yet the cause or method of transmission from diseased to healthy trees could never be discovered. In attacking this difficult problem, the division of pathology of the Institute studied first aster yellows, a virus disease similar to peach yellows, and succeeded in discovering the particular insect that carries the disease. Of the hundreds of insects which live on aster plants only one, *Cicadula sexnotata*, a leafhopper, has been able to carry the virus from diseased to healthy plants. And strange enough the disease can be transmitted only after the insect has incubated the virus for 10 to 12 days. After this period of time has elapsed, the insect can inoculate large numbers of plants, including not only asters but more than 100 other species. This is only the first step in solving the problem, for it remains to be discovered what the insect carries that causes the infection. The carrier of peach yellows has not yet been discovered, but the pathologists and entomologists are "on the trail." After the carrier and the "thing carried" are discovered the final problem is to work out methods of effective control.

The virus problem is also being approached from the chemical standpoint. Results thus obtained indicate that the virus is a chemical rather than a biological agent. For instance, the virus may be precipitated with safranin, the precipitate decomposed, and the virus recovered; two volumes of acetone when added to juice from diseased plants throw out a precipitate which contains practically all of the virus. The virus may also be salted out with ammonium sulfate. In fact, it has been found possible to remove 90% of the solids from juice of diseased plants and retain almost all the virus in the remaining 10%. From this latter fraction a very definite crystalline product has been obtained. This crystalline material, after being freed of mother liquor, gives a highly infectious solution when redissolved in water. Fortunately there has been worked out at the Institute a method for quantitatively testing virus concentrations which have been obtained by means of the different methods of precipitation.

MICHROCHEMISTRY

Macrochemical technic enables one to determine the quantity of a given substance in the stems or leaves as a whole while microchemistry enables

Photograph by George H. Van Anda

GREENHOUSE ILLUMINATED AT NIGHT BY GANTRY CRANE

VIEWS OF MICROCHEMICAL LABORATORY

one to locate the substance in the plant organs. It is of significance, for example, to know whether starch is in the root tip only or whether it is equally distributed throughout. With a technic to study very small amounts of compounds it has been possible to study changes taking place in seed coats of light sensitive seeds. Such seeds have iron in their coats and this may be related to their sensitiveness.

A study is under way to determine how phosphorus functions in plants, and its relationship to the synthesis of protein. It has been possible to

TOMATO GROWN UNDER ARTIFICIAL LIGHT ENTIRELY EXCEPT THE CONTROL PLANT GROWN IN THE GREENHOUSE AT THE SAME TEMPERATURE

5-, 7-, 12-, 17-, 19-, and 24-hour periods of illumination in every 24-hour day. This shows the tendency of the tomato to die off on the longer day lengths and to continue to live with a short period of rest in every 24-hour day.

separate a nitrate-reducing substance free from other enzymes in clear solution. Nitrates must be reduced to nitrites and possibly to ammonia before they can be synthesized into proteins, but there is some relationship between the process and the presence of phosphorus. Experiments are now under way to find out what the relationship is.

LIGHT AND PLANT GROWTH

The investigations under this head are concerned with the effect of controlled conditions on plant growth. The conditions under control are

light, temperature, humidity, and carbon dioxide. The conditions are applied throughout the life history of the plant from the seedling stage to maturity. Plants vary widely and no one set of results will apply to plants in general. For example, it was found that tomato plants suffer from continuous illumination. In fact, the plants die in a short time if given more than a 19-hour day. Most other plants can endure continuous illumination but with such treatment there is no marked increase in growth over a 19-hour day. With respect to flowering, plants are either short

SALVIA GROWN UNDER ARTIFICIAL LIGHT IN 5-, 7-, 12-, 17-, 19-, AND 24-HOUR PERIODS IN EVERY 24-HOUR DAY

This shows the tendency of Salvia to come into flower in day lengths of 12 hours or less and to remain vegetative in 17 hours or greater. The 17-hour day plant flowered only because it was well along when placed under the condition. Compare Salvia with lettuce.

day plants, long day plants, or indifferent with reference to length of day. For example, Salvia grows well but will not flower if given more than a 16-hour day; lettuce will grow well in a 12-hour day but does not flower until the day length is 15 or more hours. The reader will recall how readily lettuce "goes to seed" during the long days of June. Buckwheat is indifferent to day length so far as flowering is concerned but it increases in size up to the 19-hour day. To find explanations for such varying responses, the different species are being studied anatomically and chemically in the several stages of development.

By means of glass houses which transmit only portions of the light spectrum, it has been found that a plant can dispense entirely with the ultraviolet rays. Apparently normal plants were grown in complete absence of these rays. Likewise, plants were grown to maturity in a house where all the red rays were eliminated, though the plants were small, due probably to the low light intensity under the blue glass. In the house where only red, yellow, and a small amount of green rays were transmitted plants became greatly etiolated but produced seed.

LETTUCE GROWN UNDER ARTIFICIAL LIGHT

The length of the light period given each plant is indicated by the label on the jar. Lettuce has a tendency to flower when the day length is 17 hours or more, and it remains vegetative when the day length is 12 hours or less. Compare lettuce with Salvia.

CHEMICAL TREATMENTS FOR SHORTENING THE REST PERIOD OF PLANTS

Growth of most plants is periodic. Between the periods of growth, dormant buds will not develop even if given the temperature and moisture known to be favorable for growth. For practical and experimental purposes, it is very desirable to find a method whereby plants could be made to grow at a time when they would be in their normal rest period. Horticulturists could then treat and plant dormant potatoes when it is most desirable to have them grow; florists could treat and bring dormant shrubs into a warm room so as to have them flowering when they are wanted for

market purposes. With such a problem at hand, 250 different chemicals were tested at the Institute with the hope of finding improved methods of shortening the rest period of plants. The wish came true with the result that ethylene chlorhydrin, ethylene dichloride, or thiocyanate of sodium, potassium, or ammonium, if used in proper concentration, were found to shorten the rest period of potato tubers from one to four months depending upon the variety. Thiourea in addition to shortening the rest period forced several buds from the eyes of potatoes where only one or two would normally grow. The dormant buds of lilac, *Deutzia*, *Prunus*, and many

BUCKWHEAT GROWN WITH DIFFERENT LENGTHS OF DAY
Note that the maximum growth occurs here in the 17-hour day and that this plant flowers on all lengths of day.

other woody shrubs can be forced into growth by use of the vapors of ethylene chlorhydrin or ethylene dichloride. Lilacs and *Prunus triloba*, etc., were made to flower at Christmas time when they would not have flowered normally until March.

Surprisingly small quantities of the chemicals are necessary to stimulate the most dormant buds. In the case of woody shrubs, one part of the liquid chemical to 10,000 parts of air was sufficient to stimulate the buds to develop. The method of treatment consisted in placing the potted plants in a small room and exposing them to the vapors for 24 to 48 hours.

The next step is to discover what is the regulatory mechanism which forces buds into rest and later liberates them. And then one wonders how these special chemicals which have been used can upset the regular mechanism of dormant buds. Experimental work for the purpose of determining the effect of the chemical treatments upon the composition and physiological processes of the treated plants, and how soon after treatment these changes start, is now being carried out.

ARBORETUM

The Institute, being located in a region where most of the land is used for residential purposes, has need of land for growing of plant species to furnish an abundance of material for observation and research. The Boyce Thompson Arboretum is being developed as a valuable adjunct of the Institute. It will be, in a sense, an outdoor laboratory with many types of plant material as equipment. The Arboretum will occupy approximately 400 acres of land and more than 1600 species of woody plants have already been obtained for planting. In time all of the species that are hardy in this region will be represented in the Arboretum.

INSECTICIDES AND FUNGICIDES

In connection with the study on diseases of plants, work is being done to develop effective fungicides and insecticides. A sulfur compound has been secured which has proved to be effective in the control of apple scab and, unlike lime-sulfur, is so mild to foliage that it can be used with safety on roses and other ornamentals in the control of mildew. It can be combined with arsenicals in the control of codling moth and other orchard insects.

Bordeaux mixture, one of the most extensively used fungicides, is troublesome to prepare and does not keep long and therefore a satisfactory substitute would be of value. A spray material, consisting of colloidal cuprous oxide, has been developed at the Institute, and as a substitute for Bordeaux it "fills the bill" in every respect. It has the advantage of lasting indefinitely after it is once prepared and it may be shipped out by manufacturers labeled "good until used."

At present, work is being done to determine what toxicity of fungicides and insecticides is due to. The Frasch Fund, recently granted to the Institute, is making possible the study of many groups of chemicals that might be valuable for spray material.

A large number of other subjects not mentioned in this brief discussion are being studied. Interested persons are at liberty to write to the Institute for information on plant problems.

Publications

The following list of publications, emanating from the Institute since its dedication in 1924, will give some idea of the types of work which have been undertaken:

Experiments on the control of brown-patch with chlorophenol mercury.
The use of catalase as a means of determining the viability of seeds.
Naphthalene fumigation of greenhouses.
Field method of determining the saltines of brackish water.
The arsenic content of sprayed apples.
Dormancy in hybrid seeds.
Analyses of sprayed apples for lead and arsenic.
Chemical treatments for controlling the growth of buds of plants.
Hastening the germination of southern pine seeds.
Forcing dormant woody plants with chemical vapors.
A delicate method of detecting illuminating gas in a greenhouse.
Some effects of radiant energy on plants.
Tolerance of different species and varieties of plants to naphthalene vapor.
The necessity of sulfur carriers in artificial fertilizers.
Herpetomonad flagellates in the latex of milkweed in Maryland.
Quantitative relations of carbohydrates to nitrogen in determining growth responses in tomato cuttings.
Plant physiology.
The gray bulb-rot of tulips caused by *Rhizoctonia Tuliparum* (Klebh.) N. Comb.
I. Non-pathogenicity of the milkweed flagellate in Maryland. II. Geographical distribution of the milkweed flagellate, *Herpetomonas elmassiani* (Migone).
Seeds: Their tricks and traits.
Mosaic and related diseases.
The relation of *Herpetomonas elmassiani* (Migone) to its plant and insect hosts.
Points of agronomic interest in the physiology of germination.
Hastening the sprouting of dormant potato tubers.
Vegetative plant propagation with special reference to cuttings.
Germination of seeds under water.
Effect of alternating temperatures upon the germination of seeds.
The favorable effect of reduced oxygen supply upon the germination of certain seeds.
Seeds as carriers of disease.
An organism of tomato mosaic.
Growth of seedlings in relation to composition of seed.
Microchemical and morphological studies of effect of light on plants.
Attempt to cultivate an organism from tomato mosaic.
The effect of thiourea upon bud inhibition and apical dominance of potato.
Second report on the use of chemicals for hastening the sprouting of dormant potato tubers.
Boyce Thompson Institute for Plant Research.
Recent investigations regarding seeds, seed germination, and root growth in cuttings.
Germination of seeds of certain horticultural plants.
Oriental peach moth and *Aserica castanea* arrow.
Studies on aster yellows.
A physiological study of the effect of light of various ranges of wave-length on the growth of plants.
Seed germination in the gray birch, *Betula populifolia*.

Factors influencing the pH equilibrium known as the iso-electric point of plant tissue.
Germination of century-old and recently harvested Indian lotus fruits, with special reference to the effect of oxygen supply.
Comparison of the life activity of century-old and recently harvested Indian lotus fruits.
A double maximum in the rate of absorption of water by Indian lotus seeds.
The contribution of science to the welfare of the nation.
Effect of light, carbon dioxide, and temperature on flower and fruit production.
Acidification of unbuffered salt solutions by plant tissue, in relation to the question of tissue iso-electric points.
The effect of small amounts of chemicals in increasing the life activities of plants.
Precipitation of the virus of tobacco mosaic.
Tomato mosaic. Filtration and inoculation experiments.
A stable colorimetric standard for chlorophyll determinations.
Further studies in the ring spot disease of tobacco.
Multiplication of the virus of tobacco mosaic in detached leaves.
The improbability of tobacco mosaic transmission by slugs.
Development of botany in the United States.
Variation in composition of Stayman winesap apple trees.
Some effects of light and carbon dioxide on the growth and flowering of plants.
Artificial climate and plant growth.
Chemical treatments for shortening the rest period of pot-grown woody plants.
Localization of response of woody tissues to chemical treatments that break the rest period.
Growing bittersweet (*Celastrus scandens*) from seed.
Immunologic reactions with tobacco mosaic virus. (Preliminary report.)
The importance of temperature in the use of chemicals for hastening the sprouting of dormant potato tubers.
Rhizoctonia disease on certain aquatic plants.
An anatomical study of plants grown under glasses transmitting light of various ranges of wave-length.
Ultra-violet light photography in the study of plant viruses.
A cytological study of the intracellular body characteristic of *Hipeastrum* mosaic.
Accuracy in quantitative work with tobacco mosaic virus.
The effect of peat moss and sand on rooting response of cuttings.
A preliminary report on mechanical transmission of the mosaic of *Lilium auratum*.
Root formation and flowering of dahlia cuttings when subjected to different day lengths.
Mosaic disease of tobacco. I. Progress in freeing the virus of accompanying solids.
Local lesions in tobacco mosaic.
Inoculating methods in tobacco mosaic studies.
Microchemical studies of rooting and non-rooting rose cuttings.
Growth of seedlings in light and in darkness in relation to available nitrogen and carbon.
Origin of adventitious roots in Coleus cuttings.
Germination and vitality of birch seeds.
An inexpensive and quickly made instrument for testing relative humidity.
Rôle of mother tuber in growth of potato plant.
Germination and keeping quality of parsnip seeds under various conditions.
Immunologic reactions with tobacco mosaic virus.

The following publications are now in press:

Chemical changes induced in potato tubers by treatments that break the rest period.
Killing of plant tissue and the inactivation of tobacco mosaic virus by ultra-violet radiation.

Influence of light intensity and light quality upon the growth of plants.
Effect of chemicals, temperature, and humidity on the lasting qualities of cut flowers.
Vegetative propagation of holly.
Is the aster yellows virus detectable in its insect host?
The aster yellows disease.

ATTEMPT TO STANDARDIZE CHEMICAL SPEECH

Most of us mispronounce a good many chemical words. Dictionaries do not always agree and teachers of chemistry as well as others, even if they attempt to be careful in their pronunciations (many do not), have reason to feel confused. The confusion of the student is apt to be even greater; he may not even be sure at first that his teacher who says i o dĭ n e and s ŏ l′ ū t e is referring to the same thing as his teacher who says i o dīn e and s o′ l o o t. The Nomenclature, Spelling, and Pronunciation Committee of the American Chemical Society is seeking to determine usage for some of the commoner chemical words and hopes to set up some standards.

Wide coöperation is going to be necessary. The Committee is fortunate in having the help of C. A. Jacobson, whose "Pronouncing Chemical Formula Speller" is well known, that of Austin M. Patterson, whose dictionary work has been extensive, and that of an expert phonetician. Many chemists are to be asked to check a list of some three hundred words for preferred pronunciations. The Committee will be glad to hear from chemists interested in this subject. A complete report will be offered for publication.

The Ohio State University,
Columbus, Ohio

E. J. CRANE, *Chairman*

Announcing "Science Education." The *General Science Quarterly*, published for twelve years by Professor W. D. Whitman of Salem Normal School, Salem, Massachusetts, has become the official organ of the National Association for Research in Science Teaching. It will, hereafter, be published under the title *Science Education*, and will devote its pages to the teaching of science in all grades from the kindergarten to college. The first issue under the new name appeared in June, 1929. A sample copy of this issue may be obtained by writing to *Science Education*, Salem, Massachusetts. The journal is being edited by a committee of the National Association, composed of Walter D. Whitman, Salem Normal School; Earl R. Glenn, Montclair State Teachers' College; Charles J. Pieper, New York University, *Chairman*.

A CORRECTION

In the article "Insects and Chemistry" by Willem Rudolfs, which appeared in the June issue of THIS JOURNAL, the upper legend of the illustration on page 1104 is incorrect. It should read: "*Upper:* larvae have burst through the skin and have spun their cocoons on top of the caterpillar."

PAUL SCHUTZENBERGER

TENNEY L. DAVIS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MASSACHUSETTS

Some chemists have been great because of the correlations and generalizations which they have made. Such were Jabir, Stahl, Lavoisier, Mendeléeff, Cannizzaro, and Arrhenius. Others have been great because they have pushed back the frontiers of knowledge and, by the discovery of new facts, have proved or disproved hypotheses and opened the possibility of wider and wiser interpretations. In the latter class Boyle must be reckoned, and Scheele, and Bunsen—and Schutzenberger, whose centenary is to be celebrated at Paris toward the end of the present year. Some of of the facts which Schutzenberger discovered—hyposulfurous acid, the hydrolysis of proteins—are mentioned in all of the textbooks. Others, such as the carbonyl derivatives of platinum, phosphochlorplatinic acid, and the radicals, carbon-silicon and platinum-tin, are usually not mentioned at all, for they illustrate no present theory and are the beginning of researches, and of inferences from researches, which are yet to be made. They assure to Schutzenberger an even more distinguished position in the chemistry of the future.

Of Gerhardt, Wurtz, Schutzenberger, Friedel, Haller, and Le Bel, "the just pride of Alsace," Urbain[1] has recently said that they were

> the hardy champions of the renaissance of atomism, workers in a new and definitive philosophy of chemical science, heroes in a contest of giants in which they triumphed over such adversaries as Marcelin Berthelot, Frémy, and Henri Sainte-Claire Deville who, as partisans of the dominant doctrine of equivalents, opposed to the atomic theory the barrier of their genius and that of their authority. . . . The phalanx of Alsatian chemists imposed on organic molecules the severe disciplines which resulted in a complication of structure capable of manifesting itself only in the light of the atomic theory.

Paul Schutzenberger was born at Strasbourg, December 23, 1829, the son of a former mayor of the city who occupied a chair in the Faculty of Law. One of his uncles was professor at the medical school, and another was proprietor of a large brewery and father of a well-known painter. He became bachelor of letters in 1847, after having taken special courses in mathematics at the *lyceé*, and two years later passed the examination for the baccalaureate in science under a group of professors such as has rarely been assembled in a provincial city, Pasteur, Daubrée, Bertin, Lereboullet, any one of whom would have been enough to inspire an ardent love of science. Influenced by his uncle he then took up the study of medicine, but finding it repugnant and unsatisfying, he commenced more scientific studies at the same time. Early in 1850 he as-

[1] *Bull. soc. chim.*, **43**, 913 (1928).

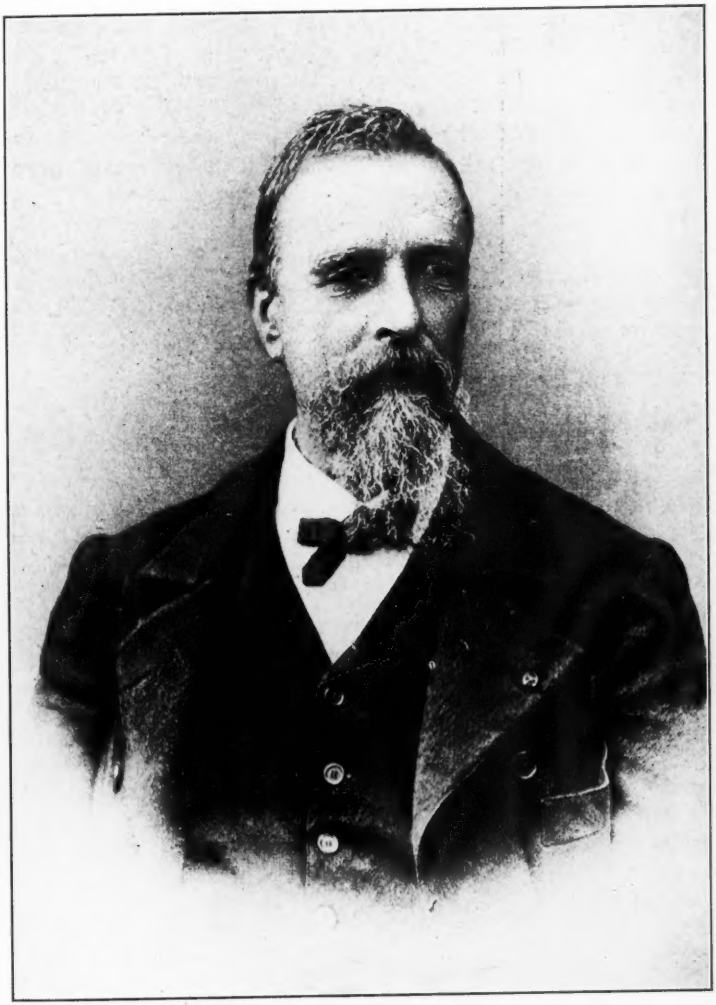
sumed, as Wurtz had done some years before, the modest functions of *aide préparateur* in the laboratory of Professor Caillot, and toward the end of the year was promoted to *préparateur en chef*. In 1853 Persoz called him to Paris to the *Conservatoire des arts et métiers* as *préparateur* for his course in dyeing and printing. The next year he was named *chargé de cours* and in 1855 *professeur titulaire* at the scientific school at Mulhouse. Here he remained until 1865, teaching with great success, studying medicine between times, and carrying on chemical research.

His first papers[2] dealt with subjects of interest to the local industry. He studied madder, isolated three new coloring matters which occur in the root in the form of glucosides—xanthopurpurine, isomeric with alizarine, purpurine, and pseudo-purpurine—and showed that alizarine and purpurine are the only substances of madder which enter usefully into the dyeing of textiles. He isolated carminic acid from cochineal in a crystalline state and prepared its ethyl ester, isolated luteoline from *Reseda luteola*, worked with catechin from "yellow wood," and studied the reduction of isatine by hydriodic acid and of indigotine by powdered zinc and barium hydroxide. He continued his medical studies, and in 1855 was awarded the Doctor's degree upon presentation of a thesis on the bony system to the Faculty of Medicine of Strasbourg. Five years later he passed the *agrégation de chimie* of the same Faculty. In 1863 he defended at the Sorbonne his magnificent thesis, "*Essais sur la substitution des éléments et radicaux électro-négatifs aux metaux des sels*," a thesis which gave proof of the rare initiative and originality which was to characterize all of his work.

At this time the dualistic theory of Berzelius held sway in inorganic chemistry. Salts were supposed to be formed by the combination of an electronegative acid radical with an equivalent of a metal. All compounds indeed had formerly been supposed to be formed in this manner, but Dumas' discovery of the chlorination of acetic acid, and the other discoveries which had followed upon it, had driven the dualistic theory from organic chemistry. Schutzenberger thought it commonplace that one equivalent of an electropositive metal could be substituted in a salt for one equivalent of another. He attempted to prepare "salts" in which the metal had been substituted by an electronegative radical. His success undermined the dualistic theory in inorganic chemistry and made clear the necessity for the notions of structure and of valence.

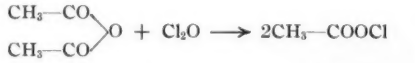
He first attempted to prepare acetate of iodine by the interaction of chloride of iodine with sodium acetate, but was unable to separate the product from the sodium chloride which was produced at the same time.

[2] The obituary "*Notice sur Paul Schutzenberger*" by Charles Friedel, *Bull. soc. chim.*, **29**, I–XXXIV (1898), is followed by a 10-page list of his publications compiled by Boudouard.

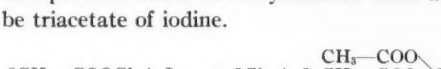


PAUL SCHUTZENBERGER (1829–1897)

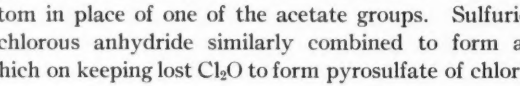
The reaction mixture on heating above 100° did, however, give the products which would be expected from the decomposition of acetate of iodine, namely, methyl acetate, methyl iodide, acetic acid, iodic acid, carbon dioxide, and iodine. Salts of other organic acids gave similar results except that the decomposition of benzoate of iodine, nitro-benzoate, etc., gave iodinated substances (iodobenzene, nitroiodobenzene, iodophenol, etc.), which had not theretofore been known. Encouraged by these results, Schutzenberger attempted to prepare his compounds under conditions where no sodium chloride could be produced. On mixing acetic anhydride with hypochlorous anhydride at a low temperature and in the absence of light, he found that they combined completely in the course of a few hours to form a single product, acetate of chlorine, isomeric with chloracetic acid, explosive and decomposable by water with the formation of acetic and hypochlorous acids.



Acetate of chlorine reacted with bromine, giving off chlorine and forming a substance which appeared to be acetate of bromine and was even less stable than the chlorine compound. When iodine was added to a solution of acetate of chlorine in acetic anhydride, the iodine disappeared, chlorine was given off in abundance, and small brilliant crystals were deposited by the solution. The product could be recrystallized from acetic anhydride and proved to be triacetate of iodine.



Schutzenberger also prepared a substance which he called "*iodol diacetochlorhydrique*" which differed from the triacetate of iodine in having a chlorine atom in place of one of the acetate groups. Sulfuric anhydride and hypochlorous anhydride similarly combined to form a sulfate of chlorine which on keeping lost Cl_2O to form pyrosulfate of chlorine, $Cl_2S_2O_6$.



The latter substance was fairly stable, decomposing only above 100° and then yielding oxygen, chlorine, and sulfuric anhydride. It burned organic substances with incandescence, and reacted with water to form sulfuric and hypochlorous acids.

The action of acetyl chloride on dry silver cyanate at a temperature below 0° gave a pulverulent product, evidently a polymer, which on dis-

tillation yielded acetate of cyanogen, a volatile, colorless liquid of pungent odor. There was also produced a small amount of acetonitrile or methyl cyanide, formed by loss of carbon dioxide from the principal product. Acetate of cyanogen was decomposed immediately by water with the formation of carbon dioxide and acetamide.

$$CH_3—COOCN \longrightarrow CH_3—CN + CO_2$$
$$CH_3—COOCN + HOH \longrightarrow CH_3—CO—NH_2 + CO_2$$

At the suggestion of Schutzenberger, one of his students, P. Miquel, later continued these researches and prepared the thiocyanates of acetyl, of silicon, of phosphorus, and of arsenic.

In 1863 Schutzenberger went to Paris as *préparateur* for Balard at the *Collège de France*. He retained that position for three years during which time he carried out and published his investigations on the acetylation of carbohydrates and other natural substances by means of acetic anhydride. That reagent supplied a valuable means of determining the number of hydroxyl groups in the molecules, for it replaced them all with acetate groups—which glacial acetic acid would not do—and the resulting acetates were soluble in an excess of the reagent. Acetic anhydride had a considerable advantage over acetyl chloride in being less volatile. The latter, too, did not always dissolve the acetates which it formed and could not be relied upon to react with all of the hydroxyl groups. By the interaction of acetate of glucose with the lead derivative of saligenin Schutzenberger synthesized the glucoside, salicin.

In 1868 the Minister of Public Instruction, Duruy, wishing to promote scientific study, created at the Sorbonne an *École pratique des Hautes Études* and confided the nominal direction of it to Sainte-Claire Deville whose interests and energies were already occupied by his work at the laboratory of the *École normale superieure*. Deville chose Schutzenberger as *directeur adjoint* and the next year caused Armand Gautier to be appointed *sous-directeur*. Schutzenberger was hardly installed in the new laboratory when he commenced with incredible ardor his discoveries and researches on the carbonyl compounds of platinum.

When a dry mixture of carbon monoxide and chlorine was passed over spongy platinum heated to about 300°, or when dry carbon monoxide was similarly passed over platinum chloride, remarkable compounds were formed which differed from all previously known compounds of platinum in being volatile. The yellow flaky mass which collected in the cool part of the tube melted at 135° and had the composition $(CO)_3PtCl_2$. This substance, when heated at 200° in a stream of dry carbon dioxide, lost carbon monoxide and left an orange-red liquid which solidified on cooling to a golden yellow mass of long needles, melting at 194°, subliming without change at about 250° in a current of carbon dioxide, and having the com-

position $COPtCl_2$. The mono-carbonyl, when heated in a stream of carbon monoxide at a temperature not surpassing 150°, combined with a second molecule of that substance to form $(CO)_2PtCl_2$, a liquid which solidified to a mass of colorless needles, melting at 142° and subliming in a slow current of carbon monoxide. The three substances underwent dissociation at elevated temperatures, losing carbon monoxide and finally yielding platinum in a state of great purity. They reacted instantly with water forming finely divided platinum, hydrochloric acid, and carbon dioxide, or carbon monoxide and dioxide.

$$COPtCl_2 + HOH \longrightarrow Pt + 2HCl + CO_2$$
$$(CO)_2PtCl_2 + HOH \longrightarrow Pt + 2HCl + CO_2 + CO$$

They reacted with ammonia gas to form the hydrochlorides of the amines which resulted from the replacement of the chlorine atoms by amino groups.

$$COPtCl_2 + 2NH_3 \longrightarrow COPt\begin{matrix}NH_2.HCl\\NH_2.HCl\end{matrix}$$

When they were treated with phosphorus trichloride, they lost their carbon monoxide and formed substances in which one or two equivalents of PCl_3 were combined with the $PtCl_2$ residue, for Schutzenberger also showed that phosphorus trichloride comported itself toward platinum in the same way as did carbon monoxide.

Warm phosphorus pentachloride reacted rapidly with spongy platinum to produce a viscous reddish brown liquid which, on cooling, yielded long brown needles of $PCl_3 \cdot PtCl_2$, m. p. 170°. The substance decomposed slowly at its melting point and sublimed in part, but it was very much less volatile than the carbonyl compounds. It combined directly with a molecule of phosphorus trichloride to form $(PCl_3)_2.PtCl_2$, m. p. 160°, yellow prisms by recrystallization from benzene, toluene, chloroform, carbon tetrachloride, or phosphorus trichloride, identical with the material produced by the interaction of the carbonyl compounds with phosphorus trichloride in excess. Phosphochlorplatinic chloride reacted with water under carefully controlled conditions to yield the tribasic acid corresponding to the replacement by hydroxyl groups of the three chlorine atoms originally attached to the phosphorus atom. The acid existed in the form of very deliquescent yellow prisms. Phosphochlorplatinic chloride reacted with absolute alcohol to form the ethyl ester of the acid, crystals from alcohol, melting at about 83° and decomposing at about 180°.

$$PCl_3.PtCl_2 + 3HOH \longrightarrow 3HCl + P(OH)_3 \cdot PtCl_2$$
$$PCl_3.PtCl_2 + 3C_2H_5OH \longrightarrow 3HCl + P(OC_2H_5)_3 \cdot PtCl_2$$

When the ethyl ester was treated with alcoholic silver nitrate, the remaining chlorine atoms were replaced by NO_2 groups. It reacted with

ammonia to form the diamine hydrochloride. It combined directly with various unsaturated substances such as ethylene, carbon monoxide, and phosphorus trichloride to form compounds analogous to the carbonyl derivatives. Phosphorus trichloride displaced other unsaturated substances from these combinations forming a compound which reacted with alcohol to form diphosphochlorplatinic hexaethyl ester.

$$P(OC_2H_5)_3 \cdot PtCl_2 \longrightarrow PCl_3 \cdot P(OC_2H_5) \cdot PtCl_2 \longrightarrow P_2(OC_2H_5)_6 \cdot PtCl_2$$

Schutzenberger prepared the methyl and amyl esters in the phospho- and diphospho- series and studied their reactions with ammonia, toluidine, and various other substances. But these numerous and interesting compounds did not suffice for his activity. During this fruitful period he discovered hyposulfurous acid and developed its applications in the laboratory and in industry.

Schönbein, the author of so many unexpected observations, had previously remarked that a solution of sulfurous acid, allowed to stand in contact with zinc, turned yellow and rapidly acquired the property of decolorizing a solution of indigo. The decolorization was obviously due to reduction, for the colorless solution resumed its blue color on exposure to the air. When zinc acted upon sulfurous acid, the reducing power of the liquid, as determined by titration with permanganate, increased to a maximum after which it gradually dropped off. Schutzenberger found that the maximum corresponded to one and one-half times the reducing power of the original sulfurous acid, but was not able to isolate the new acid which was formed. He prepared the pure sodium salt by allowing zinc to react with a freshly prepared concentrated solution of sodium bisulfite in the absence of air. The zinc dissolved with the production of heat but without evolution of hydrogen. On chilling, the liquid deposited crystals of the double sulfite of sodium and zinc, the mother liquors on dilution with nine or ten volumes of alcohol deposited more of the same substance, and the supernatant liquid, decanted quickly and set aside, yielded a felt-like mass of fine white needles of the sodium salt of hyposulfurous acid. In the air the crystals warmed up and were oxidized to bisulfite. Mineral acids decomposed their aqueous solution, turning the liquid orange-red with the liberation of hyposulfurous acid, but acetic acid was without action.

Schutzenberger and Risler applied hyposulfite to the determination of oxygen in gaseous mixtures and to the determination of dissolved oxygen in water, etc. A solution of indigo sulfonic acid, exactly decolorized with hyposulfite, reacted with the oxygen to produce a blue color the intensity of which was measured colorimetrically or by titration with a standard solution of hyposulfite. The method could be used for the determination of the oxygen fixed by the hemaglobin of the blood, and was applied by

Quinquaud, a student of Schutzenberger, in his researches in pathological chemistry. Schutzenberger and La Lande, by treating sodium bisulfite with zinc, then with slaked lime, and then with powdered indigo, developed practical methods for the production of very concentrated solutions of indigo-white, and showed the usefulness of such solutions in making up baths for the dyeing of wool and cotton and in printing with indigo on cotton fabrics.

In 1870 Schutzenberger's productive activity was interrupted by the Franco-Prussian War. When he was not doing his turn of guard duty on the ramparts, he was engaged in supervising the extraction of saltpeter from the cellar-plaster, cellar-walls, etc., of the beleaguered city. When the treaty had been signed and the days of the Commune had passed, he returned to his work with his accustomed ardor. He continued to study the uses of hyposulfite, discovered a crystalline compound of bromine with ether, and examined the products of the hydrolysis of yeast-substance, identifying phosphates, leucosine, tyrosine, carnine, xanthine, sarcine, alcohol, and carbonic acid. While the results were interesting in themselves, they had the greater importance that they led their author to undertake his monumental work on the hydrolysis of proteins. The beginning of the researches dates from 1875.

In 1876, after the death of Balard, Schutzenberger was called to the *Collège de France* to succeed his former teacher in the chair of mineral chemistry. In 1882 he became director of the *École municipale de physique et de chimie de la Ville de Paris*, which he had organized with the help of Alsatian friends after the model of the school at Mulhouse, a school "which did as great honor to Alsace which conceived it as to the city of Paris which founded it." With the help of his students he was able to carry out "the truly frightful number of experiments and analyses" which occupied about fifteen years of his life and which gave the first clear idea of the general constitution of proteins. The truths which he established are known to every student of elementary organic chemistry.

His studies on the hydrolysis of proteins led him to examine the behavior of carbohydrates, cane sugar, starch, gum, etc., under similar conditions. He was the first to prepare the cyanhydrines of glucose and levulose and to hydrolyze them to the corresponding acids, thus suggesting a method which Fischer extended by reducing the acids and applied with great success to his work on the synthesis of sugars. Other contributions of Schutzenberger to organic chemistry ought to be mentioned—the isolation of cyclic hydrocarbons from Caucasus petroleum, and the study of the action of sodium and of potassium on benzene vapor at 200°.

It is impossible in a short article to mention all of the researches of Schutzenberger, much less to describe them. A mere list of his publi-

cations covers ten pages and supplies abundant evidence of their importance and diversity. We are obliged to limit our attention to those which are most significant or which best show his originality. Among the latter his research on the platinostannic radical is very remarkable.

Alloys, whether mixtures or compounds of metals, commonly dissolve in acids to yield a mixture of the salts of the several metals which they contained. Schutzenberger fused together one part of platinum and four parts of tin, dissolved out the excess of tin with dilute hydrochloric acid, and found that there remained a residue of thin crystalline leaflets resembling graphite. These were the chloride of the platinostannic radical. On treatment with ammonia water, they yielded the hydroxide and that, reduced by heating in hydrogen, yielded the radical itself, Pt_2Sn_3. The metallic radical on direct oxidation gave the oxide, $Pt_2Sn_3O_3$.

His work on platinum led him further to a study of what he called "dry diffusion." When a current of cyanogen was passed over platinum sponge at a dull red heat, nitrogen escaped and a black, infusible, insoluble platinum carbide, PtC_2, was formed. Acetylene was decomposed in the same way; the platinum sponge swelled up and formed a black carbonaceous plug which finally stopped the tube. The plug consisted largely of finely divided carbon, but it contained platinum throughout its mass, less platinum at the points more distant from the original position of the piece of platinum sponge. Iron showed similar behavior. Certain hydrocarbons on passing through an iron tube heated to dull redness were decomposed and deposited carbon. The whole mass of carbonaceous plug was found to contain iron, even the central portion farthest removed from the walls of the tube. These researches were carried out with the collaboration of Colson, as were also those on the carbon-silicon radical.

The "nitride of silicon" which Wöhler had discovered was not affected by oxygen at a red heat, but it burned in contact with lead chromate and yielded carbon dioxide. It was found to be the nitride of the carbon-silicon radical, Si_2C_2N. The action of cyanogen on silicon at a bright red heat gave the same product and confirmed the formula. Carbon dioxide reacted with silicon at a white heat to form silica and the oxide of the same radical, thus—

$$3Si + 2CO_2 \longrightarrow SiO_2 + Si_2C_2O_2$$

The silica was removed by means of hydrofluoric acid and the oxide remained as a very stable yellow powder which would not burn in oxygen but which produced carbon dioxide when burned with lead chromate. Schutzenberger later succeeded in isolating the radical, Si_2C_2, and in preparing some of its compounds with sulfur.

He also discovered allotropic forms of certain of the metals, such as copper, silver, and lead, which he prepared by electrolyzing solutions

of their salts with a very weak current. The allotropes were very easily oxidized and were suspected of being hydrides. The doubt was settled in the case of copper at least, for allotropic copper, heated in a sealed tube at 140° in the presence of water, went over to ordinary copper without the liberation of gas.

During the latter part of his life Schutzenberger became interested in the difficult problem of the separation of the rare earths, and the vigor with which he attacked it undoubtedly contributed to hasten his death. He apparently recognized the possibility of isotopes, but had not pushed his experiments far enough to be willing to choose between alternative explanations. As Friedel wrote in 1898:

> He was visibly brought by his last researches to admit two hypotheses between which we do not see how he had chosen, a fact which makes it probable that his choice had not been made: that of the variability of the atomic weights of the elements and that of the existence of strict families of elements having very sensibly the same properties but with atomic weights which might be notably different.

Schutzenberger was a ceaseless worker without time or inclination for the social contacts which result in popularity. Though bashful in the presence of men, he showed no diffidence toward nature and none toward the prevailing hypotheses and theories of chemistry. He strove with all his efforts to obtain the answers to the questions which he was able to put to nature. The conclusions from his experiments were often unorthodox—but so were the experiments themselves—and the conclusions were not accepted until they had been weighed, considered, and tested. He was made *Chevalier de la Légion d'honneur* in 1869, and *Officier* in 1883. He was president of the *Société chimique de France* in 1872 and in 1884. In the latter year he replaced Wurtz in the *Academie de médecine*. He received the gold medal of the *Société industrielle du Nord de la France* in 1881. The *Académie des sciences* awarded him the Jecker prize in 1872, and in 1888 by an almost unanimous vote elected him a member of the chemistry section to replace Debray. None of the honors or emoluments which he received affected his mode of living or diminished his ardor for work. He died at Paris in 1897.

Amid the diversity of his researches Schutzenberger still found time to write several books. The earlier ones related to special fields of applied chemistry to which he had himself made contributions, the later ones were textbooks.

"*Traité de chimie appliquée á la physiologie et à la pathologie animale*," 500 pages, 8vo., V. Masson et fils, Paris, **1863.**

"*Traité des matiéres colorantes*," 2 vols., 8vo., 550 and 630 pages, V. Masson et fils, Paris, **1867.**

"*Les fermentations*," 278 pages, 8vo., Germer-Bailliere, Paris, **1875.**

"Eléments de chimie pour la classe de philosophie," 342 pages, small 8vo., Hachette et Cie., Paris, **1881.**

"Traité complet de chimie générale," 7 vols., large 8vo., 600–700 pages each, Hachette et Cie., Paris, **1880–1894.**

"Leçons de chimie générale," 586 pages, large 8vo., Doin, Paris, **1898.** Posthumous publication edited by Boudouard.

The *"Traité complet de chimie générale"* is a monument ofchemical erudition. It contains in an original and often unexpected form an abun-

CENTENARY PLAQUETTE, JUST ISSUED BY THE FRENCH MINT, WHICH IS TO BE USED IN CONNECTION WITH THE SCHUTZENBERGER CELEBRATION AT PARIS NEXT DECEMBER

dance of material on inorganic and organic chemistry. It is a condensation of the teachings, reflections, and vast experience of its author. Urbain recently said that:

The *"Traité de chimie"* of Schutzenberger is comparable to only one—to that of Lavoisier. For a century all of the successively published treatises on chemistry, while completing it more or less, have reproduced the treatise of the glorious founder of modern chemistry. All, save that of Mendeléeff, and that of Schutzenberger.

Schutzenberger could not imitate any one. The plan of his treatise on chemistry belongs to him personally. He breaks with the secular tradition of too convenient monographs to substitute for it the comparative study of functions which he transposes from modern organic chemistry to chemistry as a whole. And the work ends with a living and enthusiastic exposition of the nascent theories of physical chemistry, the importance and future of which he had understood in spite of his advanced years.

After the death of Schutzenberger his friends and colleagues caused a marble bust of him to be made and presented it to the *École municipale de physique et de chimie de la Ville de Paris* of which he had been director. The bust, "made with much talent by G. Urbain, a former student at the school," and, as Friedel said, "*aussi bon chimiste que statuaire*, reproduces in a striking manner, although made after the death of its model, his characteristics and his expression, at once serious and gentle, fine, and animated, the artist having only to make an appeal to his memory and to reproduce what he had seen a hundred times in the lectures at which he had assisted." Urbain has since become most distinguished for his work on the rare earths. As president of the *Société chimique de France* he spoke at Strasbourg in July, 1928, on the occasion of the inauguration of a bronze memorial tablet of Schutzenberger in the chemistry amphitheater of the University. He designed the plaquette which is to be used in connection with the celebration at Paris next December.

* * *

Note. The *Comité du Centenaire Schutzenberger* is collecting funds for the establishment of a Schutzenberger prize at the *Institut de France*. Contributions may be sent to M. G. Meker, 11 Avenue Casimir, Asnières (Seine), France. A bronze replica of the plaquette will be sent to those who subscribe more than 100 francs ($4.00), a silver replica to those who subscribe more than 1000 francs.

Pyrites Production in Spain. Production of copper and iron pyrites in Spain during the past three years has averaged approximately 3,620,000 metric tons. The 1926 production was 3,650,390 tons; 1927, 3,602,870 tons; and 11 months of 1928, 3,606,710 tons.—*Chem. Age*, **20**, 554 (June 8, 1929).

Lower Cost for Acetate Films. In about a year the cost of photographic film with cellulose acetate base, now about one-fifth higher than the dangerous cellulose nitrate film that caused the Cleveland Clinic disaster, may be reduced so that it competes in price with the nitrocellulose variety. This is the prediction of chemists who foresee future price declines in the costs of the raw materials, acetic anhydride and acetic acid, that enter into the manufacture of the cellulose acetate film base. New methods of manufacture of acetic acid and its compounds from alcohol are likely to bring about a price reduction of acetic acid from about 14 cents to 8 cents a pound.

Higher cost of the acetate films has been one of the chief factors in the continued use of the explosive cellulose nitrate films for x-ray use in hospitals despite the acknowledged danger that large quantities of such films entail. Lower cost for acetate films is expected to speed their use and reduce the hazards of storage of all sorts of films, whether in hospitals or elsewhere.

Laws and regulations are likely to require in the near future that the use of the safe acetate films shall be extended to ordinary photographic negatives, commercial motion picture film, etc. The 16 mm. or reduced size film is already manufactured only on safety stock.—*Science Service*

CANCER AS A WORLD PROBLEM

Joseph Colt Bloodgood, Surgical Pathological Laboratory, The Johns Hopkins University, Baltimore, Maryland

Chemistry is a fundamental science and most of the problems in chemistry are world problems. Cancer is becoming the chief cause of death in those races in which modern medical science has increased the length of life. The longer one lives today the greater is the probability of cancer developing, just as the greater are the chances of accident by automobile.

Chemists will be interested in the fact that at the present moment we need and are searching for a differential stain to distinguish the cancer cell from the abnormal cell that is not cancer and from the normal cell that looks like cancer, but which has been displaced by injury or infection. The Surgical Pathological Laboratory of The Johns Hopkins University has been enlarged for research through the special gift of Francis P. Garvan, President of the Chemical Foundation, and through a gift of ten thousand dollars a year we are preparing, with the aid of the Color Laboratory in Washington, to test out all stains, both on the frozen section of the fresh tissue from the operating room and on the huge tissue material that has been preserved in this laboratory for forty years. Through the enlightenment of the public, cancer is becoming a microscopic disease. For the best protection of the patient this microscopic disease should be recognized in the operating room by immediate frozen sections. The technic of frozen sections is established. The Terry polychrome methylene blue is an excellent one for frozen sections, but it does not differentiate the cancer cell from the abnormal cell that is not cancer or from the normal cell. Many members of the medical profession are not familiar with this difficulty. The majority of the hospitals of the world are not even properly prepared for frozen-section diagnosis in their operating rooms, but in those communities in which the people are enlightened the surgeons and pathologists in their hospitals are confronted more and more with the difficulties of distinguishing the earliest stage of cancer from pathological lesions that are not cancer. This is the stage that offers most for the cure of cancer. When the little area is situated in the skin or the mucous membrane of the mouth or is a small tumor that can be completely removed, this exact differential diagnosis is of no practical importance, because the entire zone of the palpable disease can be removed. When, however, it is a lump in a woman's breast, the ability to distinguish with certainty in the immediate frozen section the tumor that is cancer from the one that is not, means that the woman who has a lump that is not cancer will not lose her breast. It is even more important when the disease is in the bone, because if the bone disease is cancer (sarcoma type), the entire bone must be resected or the limb amputated. A certain differential diagnosis, therefore, means the saving of the function

of the limb if the disease is not cancer. When women are properly informed and are influenced to act at once, and when all married women who have borne children submit to periodic examinations, the number of lesions of the cervix and body of the uterus which come under observation which are not cancer and the number which are in the earlier stage of cancer will be relatively very large, and we need here a differential stain.

It is my opinion that the diagnosis of cancer in the operating room is a world problem and that the search for a differential stain is also a world problem.

Granting that we have educated the people and that periodic examinations are established, that every individual seeks the help of the medical profession the moment he is warned, that the differential stain has been discovered and frozen sections are established in every operating room in the world, the cure of cancer will not even then be complete. The probabilities are that cancer of the skin and the mouth will be wiped out. Cancer of the cervix of the uterus may be wiped out. The ultimate cure of cancer of the breast will be increased from ten to seventy per cent. But many cancers are inaccessible at present and we must at least grant that thirty per cent of cancers recognized early and completely removed will have metastasized.[1] For this reason we must search for the cause of cancer and for its prevention and cure. No one today can prophesy which medical science will ultimately control cancer. Many of us believe that chemistry has a far better chance than bacteriology. Some of us are of the opinion that the control of cancer will rest upon an organized attack of all the medical sciences, in which perhaps a new science may develop. At the present moment chemistry is taking its part in the search for a differential stain and the function of the cancer cell, as distinguished from the function of the abnormal cell which is not yet cancer, and the normal cell. Chemistry is interested in the possible chemotherapeutic agent which may ultimately prevent, cure, or control cancer.

There is therefore ample justification for an article on cancer in the JOURNAL OF CHEMICAL EDUCATION.

Cancer Facts

As cancer has become one of the chief causes of death throughout the

[1] This figure, 70% of five-year cures if the glands are not involved, is found universally in the best statistics throughout the world. It may vary in different types of cancer and in the same types of cancer in different localities, but the point is that when the local lesion has assumed the microscopic appearance of fully developed cancer there is always opportunity for general metastasis even when the neighboring lymphatic glands have been removed and found free of cancer cells. This fact that surgery offers only 70% of permanent cures for fully developed cancer and the possibility and even frequency of cancer in inaccessible regions, is the evidence that should stimulate us to an organized effort in Cancer Research. Results of radium and x-ray treatment of cancer in all stages do not even modify this statement.

civilized world, it is now recognized as a public health problem. It will soon be attacked as a world or international problem. It is only within the past five years that the medical profession interested and working in public health has become also interested in cancer. Everything that is known about cancer can be put into simple language, so that any reader without technical knowledge can understand it.

Cancer does not belong to the diseases which become epidemic or pandemic. Therefore, the Red Cross workers will not be called upon to help control its fearful destructiveness of human life, but in times of quiescence from catastrophies or pandemics, the Red Cross organizations throughout the world can join forces with the press, the radio, the medical profession, the social workers, the nursing profession, and the dental profession in the educational program and effort which have for their object to bring to children in the primary schools as well as to adults that correct information about cancer which all must have for their protection. At the present moment our greatest protection against death from cancer is through education. The campaign of the Red Cross Society against accidental deaths and wounds, including "safety first" and first aid, is almost identical with the campaign against cancer.

Cancer Research

The point is, there is not enough money spent in cancer research throughout the world today in a concerted effort to get at the cause of cancer. Last fall (1928) Surgeon General Cummings, of the United States Public Health Service, called together in Washington a committee of experts from the different sections of the United States. This Public Health Department of the United States Government has undertaken cancer research only in the past four years and is doing very excellent work with a small appropriation in one of the laboratories of the Medical Department of Harvard University. General Cummings desired advice of these experts and made the statement that there is not more than $400,000 expended annually in the laboratories of medical science in research into the nature of cancer and its possible prevention and cure. In contrast to this meager amount, one state of the United States of America—Massachusetts—has spent during the past few years more than $250,000 a year on the care of cancer patients in that commonwealth, and upon an educational program, but nothing on research.[2]

[2] Since this was written, my friend and colleague Bigelow, Commissioner of Health in Mass., has objected to this statement. He writes me that the Department of Health has done considerable research into the problem of cancer, but it has not been the type of pure research which has for its object the discovery of the cause, the prevention, and the cure of cancer. Important as clinical research is in the diagnosing and treatment of cancer, the ultimate cure of cancer depends upon a different type of research, and the question is, "Should Mass. devote 40% of its annual allowance for pure cancer research?"

As an indication of progress in this country we have these statements to make. One state, Massachusetts, has made cancer a public health problem and has appropriated the sums just noted and ordered the public health department to proceed along definite lines with the hope of some control of the disease. I have already mentioned that the Department of Public Health of the United States Government has entered the field of cancer research. The American Public Health Association which brings together in one convention all the public health officials not only of the forty-nine States, but of the cities and counties of the states, at its meeting in Chicago a few months ago, had a symposium on cancer lasting half a day. This was the first symposium on the disease in the history of the association. The American Society for the Control of Cancer, a national organization now well endowed, which has been attempting to educate the people of this country since 1913, has undergone an entire reorganization and has elected thirty trustees representing every medical science and every possible activity. The city of Philadelphia has made a complete survey not only of the number of cases of cancer within its city limits, but of exactly what is being done in its recognition and treatment, and the results. Delaware, one of the smallest states of the Union, with less than 300,000 inhabitants, has within the past three months formed a very large active State Cancer Committee and has raised sufficient money with the help of the National Cancer Society to start a survey. There is no question about the interest of the American public in the cancer problem. They not only want the correct information given them, but they have made up their minds to appropriate funds through their representatives in the legislatures in the several states to provide the strongest x-ray apparatus and a sufficient amount of radium, so that every citizen of the state suffering from cancer will have the benefit of radiation when it is indicated, or when the disease has passed the stage of palliative treatment or a cure by surgical operation. For years the very best surgical talent and hospital equipment have been at the disposal of all the people in the majority of the states.

When the new board of trustees, thirty in number, of the American Society for the Control of Cancer met in New York in April, 1929, these four topics were selected for discussion: (1) What are the most effective methods of getting before the public the correct information in regard to cancer, conditions which may precede cancer, and factors which may cause cancer?

(2) What shall be the organization of the various state, city, and county committees which represent the National Cancer Society in various communities throughout the United States? Each one of the committees is not unlike the board of trustees of the national organization, and their duties are much more than educational. Fortunately, we have the opportunity of studying twenty-six years' experience of various kinds of state and local committees.

(3) The Organization, the function of which will be to care for the cancer patient, either in the precancerous stage or in the very early favorable stage, and at all later periods including the hopeless terminal period. This organization must be prepared with every new diagnostic method and therapeutic agent. There is considerable difference of opinion among the medical profession in this country as to whether there should be special cancer clinics, and the exact type of the organization of such clinics.

(4) Research.

I propose now to outline briefly what I look upon as the essential features in these four problems, and if any dogmatic opinion, or an opinion of any kind, is recorded here, it must be looked upon as a personal one and not, at least as yet, agreed to by all my colleagues, whether on the board of trustees of the National Cancer Society or not.

There has never been more literature on cancer than during the past two years. I have in my hand now a book of 588 pages, entitled the Cancer Conference of London, 1928. This was called together by the British Empire Cancer Campaign. There are more than one hundred and thirty articles, and practically every phase of the cancer problem is discussed. Then there is a smaller publication of the Lake Mohonk Cancer Convention, called by the American Society for the Control of Cancer in 1926; and I have before me the page proof of Cancer Day, which was held in Baltimore in September, 1926, called together by the Maryland State Cancer Committee but made possible by the generous support of the medical profession of Baltimore and the state of Maryland. The "*Index Analyticus*," under the editorship of Professor Regaud and his colleagues in Paris, is now in its third volume and the *Cancer Review*, edited under the direction of Doctor Murray of London, has been in existence a little longer. No disease has a better and more available bibliography. I will not mention the special cancer journals nor attempt to give an idea of the large percentage of cancer articles which appear in every medical journal throughout the world.

The Educational Outlook

When I graduated in medicine at the University of Pennsylvania in 1891, cancer was practically a hopeless disease. In the first place, almost everybody, including members of the medical profession, came under treatment only after the disease was in a hopeless stage. In the few instances—due to accidental causes—when the patients did come under the care of the medical profession with cancer in an operable stage, there were very few surgeons who had either conceived or executed what is now known as the complete operation for cancer. Billroth formulated and executed on dogs and later upon human beings the complete operation for cancer of the stomach in 1884, but no resections were performed during the curable stage

until many years later. It would appear that Halsted first conceived and executed his complete operation for cancer of the breast in 1885. His first publication appeared in 1895, and at the time of that publication fifty per cent of the patients were living and apparently free from recurrence at the end of three years. Wertheim published the details of his complete hysterectomy for cancer of the cervix before 1900.

It was my good fortune to be associated with Professor Halsted at Johns Hopkins and to accumulate since that time in the Surgical Pathological Laboratory of the Johns Hopkins Hospital and University many thousand records of cancer cases, the pathology of which is not only recorded there, but from which the tissues and microscopic sections are preserved for restudy.

The records of this laboratory tell the history of cancer in this country since 1889. We know the percentage of inoperability in each year, and we can group together in each decade and show graphically that inoperability has gradually decreased from more than fifty per cent up to 1900 to less than ten per cent since 1920, and the actual cures by operation alone have increased from less than ten per cent to more than sixty per cent.

But far more striking are these changing figures. Previous to 1900 the percentage of cancer as compared with tumors that were not cancer, was as eighty is to twenty. Since 1925, in many localities, especially in external cancer, the figures have been reversed, the non-cancerous or benign tumors are eighty and cancerous or malignant are twenty per cent.

But the records of this laboratory show even more favorable results than this. Previous to 1900 the proportion of individuals who sought the advice of the clinic for local lesions or conditions that were not cancer, but which we now know usually precede cancer, was less than three per cent. Since 1920, the actual per cent of these individuals who are in a stage in which as yet they have not cancer and can be largely protected from cancer, is more than sixty-five. It is important to note that I have been attempting to record this in the literature since 1902. My colleagues throughout the world, in writing on the control of cancer, give the Surgical Pathological Laboratory of the Johns Hopkins University and Hospital a great deal of credit for the repeated publication of these figures. At the present writing I look upon these statistical studies as the most important contributions of this laboratory. It is figures such as these that demonstrate the value of a united, organized international effort. It was this phase of the cancer problem that Dr. George A. Soper, the Director of the American Society for the Control of Cancer, selected for my paper before the Lake Mohonk Cancer Conference in September, 1926.

The reduction of the number of patients in the inoperable or hopeless stage, the actual cures by surgery or radiation, the increase in the number of patients who come for diagnosis and treatment before the stage of cancer,

can be accomplished only by some educational system. A survey of what the world has done today forces the conclusion that, with the exception of certain localities in the United States, every other locality throughout the civilized world is lagging in its educational effort, and apparently does not appreciate that at the present moment it is the most valuable therapeutic agent. I am confident that if we could get the actual figures in the different countries and in different localities of the same country throughout the world we would find that the per cent of hopeless cancer, of five-year cures, of the precancerous stage, are in direct proportion to the educational effort by the medical profession and to the capability of the people in that locality to understand. There is no question that with the same educational program more rapid progress will be made with one group of people as against another. From my studies of this subject I am almost convinced that the larger number of children attending public schools and a larger number whose education extends into high school and university, create an enlightenment which can appreciate the message in regard to public health, prevention of disease, and the importance of early recognition and treatment for the cure of the disease.

The more we teach children on health and prevention of disease, the less we will have to teach adults. Red Cross workers know that, if you teach the boy and girl scouts first aid there is very much less difficulty in the prevention and treatment of accidental injuries among the employees in industry when they grow up.

It also must be emphasized that protection against cancer first depends upon correct information. This information must not create more than enough fear to stimulate immediate action; that is, if an individual feels a lump, he must know that that lump should be examined at once; but he must not have sufficient fear to induce him to delay examination, hoping the lump will disappear and thus save operation.

The finesse of the educational campaign is to give the knowledge so it will be clearly understood and not create a phobia and induce the human being to act like an ostrich.

Dependence of Research on Public Education

For the moment we can skip the problem of state organizations and the cancer clinic, because, on the whole, our therapeutic agents—surgery and radiation—seem to have reached their limit. We must either increase tremendously the percentage of patients in the precancerous stage, or in the earliest stage of cancer, or discover, through research, the actual cause of cancer which will lead to some more specific and certain preventive or curative treatment.

The trouble with cancer research at present is the same as that with any

other form of research in the medical sciences—it receives insufficient financial support and is not attractive to a sufficient number of the best intellects in the young men and women who are studying medicine today.

With few exceptions, the people themselves have not voted money for cancer or medical research. In this country, our medical schools have undergone a startling reorganization. No one can study medicine today without a fundamental education in medical science and, with few exceptions, no one receives a degree of doctor of medicine without the proper training. Most of the medical schools have sufficient money for buildings and teaching, but not a single medical department of a university in this country has sufficient money for any type of research, and the number of strictly research laboratories such as the Rockefeller Institute is very small. I believe this is true throughout the world. In a recent book, "Chemistry in Medicine,"* the editors in their foreword make the following statement: "The most effective way to accelerate the successful issue of any undertaking is to attract to its standards the brainiest and boldest among men, and in this case to multiply the number of well-trained investigators." It looks to me very much as if research today was in the stage that cancer was between 1890 and 1900. To make research more effective, there must be the same educational campaign that has made cancer less dangerous. For every sixty dollars spent on the educational campaign against cancer and in the treatment of cancer, at least forty dollars should be expended on research.

To keep this paper within proper limits, we must leave further discussion to subsequent contributions, especially as I am anxious, in the first place, to emphasize the educational problem. Research has gone not very far. It has established the relation of chronic irritation to cancer. This was first known from clinical studies. Then cancer has been produced in animals by various types of chronic irritation. The following stage is that of the transplantation of tumors in animals, a work that has proceeded for years and is going on successfully in many laboratories throughout the world. In spite of the fact that we can produce tumor transplants in thousands and study the nature and growth of the tumors and experiment with all types of agencies for their cure, we have yet added very little to the actual diagnosis and treatment of tumors in the human being. We have, however, developed throughout the world a large personnel of trained individuals and have at hand plenty of animals with tumor material and a method of adding to this in great numbers. We must now devise other methods of experimenting upon these transplanted animal tumors. We need most of all new ideas of utilizing this material in the research problem. During this period of tumor transplantation, the most valuable discovery

* The Chemical Foundation, Inc., New York City (1928).

of Rous and Murphy of the Rockefeller Institute in New York took place—that of the filterable agent. This is the first time that malignant disease has been produced in animals by any other means than chronic irritation and transplantation.

The treatment of cancer in the human being by surgery has reached its limit. If patients can be educated to come in time, cancer in accessible regions can be recognized and removed with a large per cent of permanent cures, in some cases, like the lip and skin, in one hundred per cent; in the mouth eighty to one hundred per cent; in the breast seventy to eighty per cent; in the stomach and colon, in very early cases, in over seventy per cent. So far radiation has accomplished most in cancer of the cervix and, as a palliative treatment for pain and recurrence, it is practically the only agent we have today. Cancer of the skin, mouth, and cervix of the uterus are preventable diseases. Here, in the skin and in the mouth, the individual is always warned by a local defect before the area becomes cancer. Periodic examinations of women who have borne children offers most in the control of cancer of the cervix. How much can be done with justifiable research on the human patient with hopeless cancer, cannot be estimated as yet, but it is being carefully considered in this country at the present moment. There is not the slightest difficulty in getting the patients. We are retarded chiefly by lack of organization and sufficient funds.

At the present moment, the majority of the medical profession is most interested in what can be accomplished with radium when the disease has passed the operable stage, and even many of the enthusiasts are beginning to experiment with treatment by radiation in the operable stage.

The greater number of people suffering from cancer in the world today are in the hopeless stage. They are listening in, especially in this country, for any new hope of any new cure by a member of the medical profession or by any one else. In this country, I am quite sure, the chief attention of the medical profession is given to attempts to treat cancer in the hopeless stage whether by operation or radium, or by any other new treatment that for the moment may hold the stage of public opinion. There is no doubt that the medical profession receives more financially for this attempt at curing cancer in the hopeless stage than for any other disease. It makes it difficult to gain the attention of the public and the profession to the educational and research side. We have not the slightest evidence that the present attempts at curing cancer by surgery with the knife, cautery or diathermy, by radiation, intravenous lead, or with any other method of treatment, promises any further success. The control of cancer rests on education and research. If the same attention is given to these two with the same financial support as is given now to the treatment of cancer in the late stage, we can expect tremendous improvement, as much, or even more, than we have accomplished for tuberculosis. Organized, properly

financed research offers as much for cancer as has been accomplished for diphtheria.

Each country, each investigator, each research laboratory, each cancer clinic can, by its work and the publication of its experience and ideas, be helpful in the solution of this problem.

A New Motor Spirit, claimed to possess exceptional anti-detonating properties owing to the addition of certain material derived from the crude oil itself, was announced by Sir John Cadman, chairman of the Anglo-Persian Oil Co., at a luncheon given recently by the British Petroleum Co., Ltd., at the Savoy Hotel. The new spirit was to be on sale throughout the country on Thursday. The claim was made that it was an "ideal" spirit. Its volatility ensured an easy start under all weather conditions, and gave a clean exhaust; there was no free sulfur, and therefore no objectionable odor, and it was absolutely free from gum and therefore innocuous to all metal and moving parts. The spirit had been evolved by the chemical experts of the company, to whom Sir John paid a tribute.—*Chem. Age*, **20**, 568 (June 15, 1929).

New Uses for Lead. In addition to Amaloy, which is being used for soldering work in the automobile industry and in the manufacture and installation of electrical equipment, a few other new uses for lead have come into prominence lately, and some of these may develop into important items of consumption, says Lewis A. Smith, in a report recently issued by the United States Bureau of Mines, Department of Commerce. In building construction, interest is evoked by the use of lead mattresses to act as shock absorbers between the foundations and the steel framework of skyscrapers. In one building in New York about 55 tons of lead appears to have been used for this purpose.

In the pigment field a new lead preparation called "Subox" has been introduced. This preparation, which consists of very finely divided particles of lead suboxide suspended in linseed oil, can be sprayed or applied with a brush upon any surface. After being applied it undergoes a slow transformation, resulting in a film of metallic lead held firmly as a protective coat by the oxidized oil.—*Chem. Age*, **20**, 566 (June 15, 1929).

Responsibility of Educational Institutions. After all a country's greatest resource is the untrained talent of its rising generation. To search this out and give it full opportunity is surely a good philosophy for a democracy. Whether we represent the endowed or the publicly supported institutions, there rests on all alike the imperative obligation to exercise to the uttermost such creative imagination, such wisdom and energy and devotion as we can command, to meet the bewildering educational needs of our time and people. If the greatest experiment in self-government ever undertaken by man is to avoid the pitfalls of pervasive vulgarity and meretricious ignorance, masquerading as sophisticated intelligence; if it is to survive the sinister influence of political corruption and commercial greed; if it is to come into its heritage of great intellectual and spiritual achievement, which shall furnish the indispensable counterpart and complement to its unprecedented material accumulations, it is chiefly to education that we must look. The development of that education will call for all those human qualities of courage and vision and self-sacrifice which we justly esteem most highly. We may well pray that we be not found wanting in this supreme test of our national life.—JAMES R. ANGELL

THE IMPORTANCE OF CHEMISTRY IN HEALTH AND DISEASE*

C. JELLEFF CARR, BALTIMORE CITY COLLEGE, EVENING HIGH SCHOOL, BALTIMORE, MARYLAND

When they formulated our present government, our forefathers displayed the characteristic spirit of achievement that is America's most prized possession. This spirit has exhibited itself, occasionally, here and there throughout the world since the beginning of the American nation only to burn feebly or to die altogether. But in the scientific research laboratories of the world, and especially in America, it has been fostered and enriched until finally, sweeping the universe, it has rocked the very foundations of disease and started millions on the highway of health.

C. JELLEFF CARR

The excellent health of the majority of American people is an undying memorial to those frontiersmen whose names have gone down in the history of chemistry and medicine as "Architects of Health." While chemistry has exhibited its handiwork in nearly every field of human endeavor, its enterprises into the sphere of medicine have given the most gratifying results. The most outstanding of the medical problems that they have attempted to solve are the preparation of better and more powerful antiseptics, the isolation of active principles of the human glands, the discovery of better anesthetics, the building up of our knowledge of nutrition, and lastly the prevention of disease by the removal of the cause.

Antiseptics

As one enters Remsen Hall at Johns Hopkins University and starts ascending the stairs, he comes face to face with a beautiful tablet bearing this inscription. "Behind this tablet repose the ashes of Ira Remsen 1846–1927." Was there ever a more fitting memorial to any man? He slumbers

* Prize-winning high-school essay, 1928–29.

close to his beloved chemistry, so enriched, so broadened, by his undying enthusiasm. He has made approximately 180 original contributions to scientific literature, as well as eight textbooks. The dye phenolsulfonphthalein, discovered by Remsen, has served for a number of years as an indicator of the functional activity of the kidney. It was this dye, according to Krantz, that suggested to Geraghty and Dunning in 1912 the idea of combining with it an antiseptic metal. From this we have now available the drug mercurochrome, the powerful non-poisonous antiseptic which has largely replaced iodine.

Chemistry has provided many other valuable substances which, within certain limitations, are of great importance in the treatment of local infections. Bichloride of mercury is a powerful antiseptic, but like carbolic acid it is too poisonous, in high concentration, for internal use. Chlorine was employed in the past war as an antiseptic, in the form of Dakin's solution, but because it is intensely irritating and deteriorates rapidly, chlorine-containing antiseptics are not popular.

Acriflavine is a fine example of the marvelous power of the chemist to construct the molecule he desires by removing or leaving off portions which are harmful and retaining those valuable for some particular purpose. Ehrlich started with acridine yellow, an aniline dye, and so juggled the atoms within the molecule to produce the compound acriflavine. This drug is now widely used for antiseptic purposes.

Chemistry and the Glands of Internal Secretion

While the synthetic preparation of antiseptics which are quite deadly to germs and harmless to man offers an attractive field to future chemists, another equally promising, if not more important, field is that of endocrinology. The glands of internal secretion have been called the "glands of destiny," for their regular functioning is of utmost importance to our well-being. The pancreas, the thyroid, the adrenals, and the pituitary glands are most important in this class.

When Remsen gave saccharin to the world and particularly to the diabetic, how fortunate that vast army of sufferers considered themselves. They could sweeten their coffee with a material four hundred times sweeter than sugar, and yet suffer none of the ill effects that the use of sugar would have brought about. Little did they realize that chemistry would do still more for them! In 1922 Banting and Best completed their classical work on the separation from the pancreas of animals of a hormone called insulin, which when injected hypodermically relieves the cardinal symptoms of diabetes. It can be said truly that there are thousands living today who would be unable to live if their supply of this extract was cut off. Unfortunately, insulin must be administered hypodermically, therefore, the diabetic must submit himself to frequent daily injections. This is a serious

disadvantage and there is perhaps no subject which has engaged the interest of a higher class of scientific minds than this one. In the United States there are Allen, Joslin, and Wilder; in other countries Banting, Best, MacLeod, Campbell, Von Noorend, and Minkowski all searching for a good substitute for insulin. Professor Frank, of Breslau, has prepared the most hopeful product as yet produced called synthalin, a guanidine derivative, but it is the opinion of Staub that synthalin is unsuited for oral administration in the treatment of diabetes. Whether this opinion is justified will doubtlessly be proved by future researches in this field. Besides synthalin there are other blood sugar reducing drugs, such as glukhorment and myrtillin, which seem to be still in the experimental stage and whether or not they will replace insulin has yet to be determined. We must not pass on without making some note of Abel's work of obtaining insulin in a crystalline form. Jensen and Geiling, working with Abel, determined the empirical formula of the crystals and found it to be $C_{45}H_{69}O_{14}N_{11}S{\cdot}3H_2O$. These investigators have also discovered some of the products of hydrolysis of the crystals. One can readily agree that with such knowledge being accumulated the ultimate nature of this hormone may be looked for in the near future.

In 1895 Bahmann discovered iodine to be a normal constituent of the thyroid gland. This discovery led to the present treatment and prevention of goiter by administration of salts of this element. Iodine, finding itself replaced by more popular antiseptics such as mercurochrome and hexylresorcinol, has come to the front in the treatment of goiter. In 1925 further research along this line led to the preparation of a pure crystalline compound, isolated from the thyroid gland, containing 65% iodine and called thyroxin. It is principally used in the treatment of goiter to replace the material found to be lacking in thyroid insufficiency. A striking property of thyroxin is that it acts as a catalytic agent in the body; that is, it helps chemical reactions to occur but is not destroyed by the reactions. It stimulates the sluggish chemical processes of a thyroid deficient person. Only minute quantities are necessary to bring about marked physiological activity. Experimenters have shown that the total amount of thyroxin acting in the normal human body is not more than one-fifth of a grain.

Adrenalin, the active principle of the adrenal gland, is perhaps the most powerful drug available to mankind. Oliver and Schafer in 1894–5 demonstrated that an extract prepared from suprarenal glands contained a substance which, in even minute concentrations, caused a remarkable rise in blood pressure in the body. This potent material is now known to be an amino alcohol and its composition has been definitely established. In 1906 Dr. Stoltz was able to prepare adrenalin synthetically, having availed himself of the knowledge handed down from year to year by organic chemists, so that medicine is no longer dependent on the ox or sheep for its

manufacture. A remarkable illustration of the interrelation of the hormones of the body was shown by Britton and Geiling's research, which pointed out that epinephrine, as synthetic adrenalin is now called according to the United States Pharmacopeia, is utilized in the normal body to counteract to a certain extent the action of insulin. This bit of knowledge may or may not prove of value in the treatment of diabetes.

The pituitary twins, the newest offspring of endocrinology, are the posterior and anterior lobes of the pituitary gland. Both seem to exhibit very remarkable and distinct physiological activity. Extracts prepared from these lobes have found wide use in obstetrical clinics and in the treatment of certain forms of diabetes. Dr. Evans and Dr. Kamm have given to humanity a great deal of information regarding this promising new subject and undoubtedly they will add considerably more to it in the years to come.

Anesthetics

Modern surgery has made possible the alleviation of so many of man's ills that scarcely anyone is permitted to spend his span of years upon the earth without at least one surgical operation. It is at this time of peril that we make perhaps our only contact with ether, chloroform, novocaine, or ethylene, the helpmates of the surgeon—his anesthetics. These materials are pure chemical compounds. The story of their discovery and usefulness is interesting. In 1800 Sir Humphry Davy discovered the anesthetic properties of nitrous oxide (laughing gas), and Dr. Wells definitely suggested the use of it to render patients insensible to minor surgical operations. This was the humble beginning of a great boon to humanity. Since that time anesthetics have been turned out from organic chemical laboratories by the hundreds. While general anesthetics are limited to hospital and clinical use, local ones such as the numerous cough remedies, sprays, and gargles are employed daily by the layman without his realizing that it is the anesthetic which soothes the irritated tissue and gives instant relief. From the field of organic chemistry will come the greatest anesthetic of all times, the non-habit-forming drug that may be used internally or externally, locally or generally. It has not come as yet, but chemistry has not failed mankind before, surely it will not in this respect.

Vitamins

Until recent years foods were classified under four headings: fats, carbohydrates, proteins, and mineral salts. Recently various research workers have shown the presence of certain substances called vitamins to be of great importance in nutrition. People in general have become interested in this new branch of science and read enthusiastically the many articles on this subject appearing in popular current journals. "Vitamins" and "bal-

anced diet" have become ordinary household words. This field of nutrition, opened by Casimir Funk, was taken up by McCollum and Davis in 1913. These workers were able to prove the necessity of two previously unidentified substances in the diet. They called them Vitamin A and Vitamin B.

The following list is interesting in that it contains the names of some of the greatest research workers of our day, associated with the vitamins they discovered.

Lack of Vitamin A will produce xerophthalmia (inflammation of the eye), Funk, McCollum, Davis.

Lack of Vitamin B will produce beriberi, Eijkmann.

Lack of Vitamin C will produce scurvy, Holst, Frohlich.

Lack of Vitamin D will produce rickets, Hess, Steenbock.

Lack of Vitamin E will produce sterility, Evans, Bishop, Sure.

Lack of Vitamin P.P. will produce pellagra, Goldberger.

With vitamins assuming such a popular aspect, it is necessary that we do not obtain a too exalted idea of their importance, at the expense of other equally important dietary factors.

Prevention of Disease

The old adage, "an ounce of prevention is worth a pound of cure," is certainly applicable to our lives in so far as our health is concerned. Drugs or chemical compounds are man's most useful weapons in fighting disease and at the same time his best tools in preventing poor health. From the memorable work of Pasteur and Lister we have evolved our modern ideas of sanitation, the foundation of good health. These men demonstrated that infections were caused by bacteria, thereby exploding the older theory of spontaneous generation. Pasteur evolved the anti-rabies serum, for the treatment of rabies by injection of a virus, of gradually increased strength. The importance of this classical work cannot be overestimated for it has been responsible for the saving of thousands of persons inflicted with hydrophobia. The outstanding achievement of Lister was the application of antiseptics to surgery.

It has been said that the Panama Canal could have been constructed by any huge construction company were it not for the apparently insurmountable barrier of disease that prevented all attempts at construction. The United States Government, realizing the importance of overcoming yellow fever and malaria in the tropics, sent Dr. Walter Reed and his valiant company of workers to Panama. Reed, suspecting that an organism was responsible for yellow fever, conducted his researches along this line and was able to show definitely that this parasite was carried by the mosquitoes, abundant in that part of the country. To substantiate his work he called for volunteers from the army to expose themselves to the bites of infected

mosquitoes. One brave fellow sacrificed his life on the altar of truth that others might live from the knowledge gained thereby. A striking similitude, it seems, to the will of God that saw fit to take Patricia Garvan from this world. Because she died, thousands have been able to live or have been benefited by the knowledge brought to light through the generosity of her parents, who have sponsored in her memory tremendous enterprises in the fields of chemistry and of medicine.

Conclusion

Huxley once said, "The two greatest imperfections of the human race are lack of attention and accuracy." Possibly the great advances science has made have been due to the realization of the importance of these two things by scientific workers. Mathematical accuracy and careful attention to minute irregularities are the stepping stones of progress. They lead to the portals of a new future which, when thrown aside, will reveal to mankind a happy life, as radiant as the refreshed morning sun giving promise of a day of joy when pain and disease are no more. Surely we can look to the future with unswerving hearts and with optimism, not founded upon false illusions, but with an assurance greater than any our ancestors could have felt. We move forward with our hopes, ideals, and ambitions founded deep in the principles of science and our trust in the banner of chemistry. If we, traveling upon the highway of life, are so unfortunate as to make the wrong turn at the crossroads of health, then we must look to chemistry and medicine for the righting of our error. They alone offer the greatest support and encouragement for our wayward health. In the words of the beloved poet, Edgar A. Guest,

> "We are the waiters of the world,
> Debtors to every test tube curled.
> Ours is to wonder while we live
> What next the scientist will give."

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THE RELATION OF CHEMISTRY TO THE ENRICHMENT OF LIFE*

RUTH KNOBLE, FLATHEAD COUNTY HIGH SCHOOL, KALISPELL, MONTANA

Man brought nothing into the world and through long and painful ages he added little to that nothing. He might labor, but to what avail? Suffering from diseases with which he knew not how to cope, terrified by natural phenomena which he could not explain, he struggled on, gaining bit by bit the power of original and constructive thought which has resulted in the wonders of the modern world. "Never in the past has man lived in so compact a world, never has he had such facilities for intercommunication with his fellows, never has he been endowed with such control of natural forces and, above all, never before has he had it in his power to direct so definitely the course of his own development."

RUTH KNOBLE

The stellar rôle in this drama of progress, this enrichment of life, has been played by chemistry. Other sciences have, of course, played no small part, yet chemistry, because it deals with the fundamental material of all matter—elements—has affected and become part of every other science. We cannot study biology, geology, archeology, or astronomy without a basic knowledge of chemistry. The housewife, the man at the gasoline filling station, the psychologist, and the statesman must know and understand the fundamental laws of chemistry, for they are the laws of Nature, and "the laws of Nature are the will of God." By their observance only can man hope to come into harmony with the universe and with himself.

Since chemistry is woven into the very warp and woof of life, constructive achievements of the chemist represent increased knowledge and happiness for the whole human race.

* Prize-winning high-school essay, 1928–29.

The ultimate aim of human endeavor is the betterment of living conditions and the lengthening of the span of life. It is to the chemist that humanity has turned for aid.

In that master of biochemistry, Pasteur, the plea of unnumbered generations of men found answer. At last humanity was given a champion, protected not by a coat of shining armor but by a keen intelligence, and armed not with sword and buckler but with a microscope and the desire to know and be of service; a champion who was to reveal the chain which connects microbe and man and by breaking it, to deliver humanity from a thraldom under which it has groaned for unknown ages.

The result of his researches upon fermentation and spontaneous generation represents a transformation in the practice of surgery, the greatest boon ever conferred upon humanity. Joseph Lister applied the principles of Pasteur's discoveries to the treatment of wounds and from these beginnings modern surgery took its rise. At the present time there is scarcely a hospital in the civilized world where the principles of aseptic surgery are not carried out, not a household which has not benefited by it, not a physician who is unaware of its meaning. The amount of prevention of suffering and prolongation of life due to it are altogether incalculable.

As a result of the experiments of this trained chemist we now have a knowledge of the causes of disease, the means of conferring immunity, or of providing antitoxins which by their specific action upon the virus of diseases successfully save human beings, as well as the lower animals, from death and incapacitating illness.

Cholera, dysentery, malaria, smallpox, plague, scurvy, rabies, diphtheria, and many common illnesses have been practically eliminated, and so have the poverty and distress which result from them.

The discovery of anesthetics made possible surgical operations which hitherto could not have been attempted, and removed from the simplest operations the pain which previously had been an important factor in their failure.

The whole world has profited by the research of the chemist in regard to the endocrine systems of the body. Diabetes, goiter, and cretinism, as well as abnormal and subnormal physical development, are known to be caused by the improper functioning of the endocrines. The isolation and preparation of insulin, adrenalin, thyroxin, pituitrin, and a fifth specific hormone, as yet unnamed, is a gigantic stride toward the day when man will truly be master of his fate.

Leprosy has lost its curse, because it yielded to treatment with the pure acids of chaulmoogra oil combined with ethyl alcohol. Sleeping sickness no longer takes its toll in the tropics because the French chemist, Farneau, produced "Pasteur 309" which frees the body of the trypanosome (the

cause of the disease) in a few days and makes the body immune to further attacks.

The list of vanquished is long and is increasing constantly as man pushes onward in his war against disease. Before a disease can be prevented it must be understood. If a sure remedy is to be found, there must be a knowledge of its nature and transmission, and "that knowledge is obtained by the man of science," equipped with the tools of a modern chemist.

The farm problem occupies an important position, not only on the front page of the local newspaper and in the halls of the National Capital, but in the future welfare of our country and of all countries. While politicians theorize and argue, the chemist is quietly working out the farmer's destiny.

Crops are improved by chemical selection; farm animals are fed in accordance with the strictest application of the laws of physiological chemistry; insects and destructive plant diseases are controlled by chemicals; destructive animal diseases have been brought under control; the butterfat content of milk is determined by the Babcock test; and cheap and efficient fertilizers are being produced. Soil analysis and the right fertilizer mean a new life to six millions of farms.

While the farmer seeks a market for his produce, the chemist seeks economical methods of refrigeration and transportation to present markets. Dry ice, frozen carbon dioxide, is replacing ice as a refrigerant. By its use, ice cream, butter, eggs, cheese can be shipped by mail or express.

The profitable utilization of agricultural waste products has engaged the attention of chemists since we first heard the word "conservation." Liquid vegetable oils are converted into solid fats by hydrogenation; cottonseed is now the source of fertilizers, cattle feeds, oil, soap. The protein constituents of cottonseed will soon be converted into human food. Paper is made from cornstalks, and in Germany pigs are fattened on sawdust. Waste straw is converted directly into fertilizer, and hemp, soy beans, peanuts, sorghum, cottonseed, or sugar cane may have been the original source of your wearing apparel.

The chemist has given the farmer the means with which to purchase comforts and luxuries and time in which to enjoy them. This applies in varying degree to all humanity.

The importance of applied chemistry is aptly illustrated in the development of new industries and the revolutionizing of old ones, within the last decade. In some instances entire industries are undergoing rapid changes. In others, the process is less rapid but not less significant. The business which does not employ chemists to eliminate waste and produce new products is already doomed. Reduction of manufacturing costs has resulted from simplification and standardization. Mechanical engineers have produced "fool proof" machines for practically every

operation. Harder, lighter, and stronger metal alloys, the products of the chemist and the metallurgist, have made these things possible. Discoveries with revolutionary possibilities are being made almost daily.

Before the war the dye business of the world was practically a German monopoly. Today we are producing over 95% of the dyes we use. These are made by our own processes, developed by our own chemical engineers.

Part of the tragedy is being removed from the "tragedy of waste." Business has begun to realize that lack of research has hitherto resulted in millions of dollars lost in waste products. Now by-products are manufactured which often exceed the value of the original product. The prevention of waste has become almost as important as the discovery of ways of synthesizing the things that command good markets.

Carbon, hydrogen, oxygen, and nitrogen are the corner-stones upon which is being built the foundation of synthetic chemistry. The consequences of its rise are already immense and in the future immeasurable. There is no serious shortage of raw material, for water and air are plentiful and, should our supply of coal and petroleum become exhausted, cellulose can be grown anywhere except in the polar regions. With an ample supply of the necessary material for the formation of any number of unknown organic materials, as well as for the synthetic production of those now existing, why should any nation make war upon another? Much less energy expended at home would result in greater progress.

With the use of structural formulas, the chemist can now plan beforehand the most complicated compound, and then go into his laboratory and make it. The Coolidge x-ray tube, which promises to revolutionize the practices of chemists and engineers, photographs the spectra of atoms, giving the chemist a better idea of the material with which he works, and making it possible for him to do his work more expeditiously. The number of experiments necessary to obtain desired results will thus be reduced. "That the field of synthesis is limited is due only to our ignorance," says Edwin E. Slosson. We must look to the theoretical laboratory for increased knowledge, where men are seeking new truths and clearer insight into the mysteries of nature.

If the services of the chemist in the enforcement of law should suddenly be withdrawn, chaos would result. It is the chemist who ascertains the presence of adulterants in foodstuffs and determines which of these ingredients are harmful. It is he that aids in the detection of crime and he that brings the criminal to justice. The chemist purifies the city's water, disposes of its refuse, and eliminates its smoke nuisance.

The chemist has revolutionized household economics. The food supply has been broadened and stabilized; the laundry, the bakery, and the factory have assumed domestic drudgery; tasteful clothing is within the reach of all; innumerable new industries, based on the

findings of the laboratory, offer means of decent livelihood to millions, and careers to thousands. There is now amusement for the multitude—movies, talkies, radio, and phonograph programs. The chemist has put cultural advantages in every home. We have now only to assimilate that culture.

Because the manual labor of ancient Greece was performed by slaves the Greeks had time to think, and a high state of culture resulted. Today machines are our slaves. Science has given man leisure. Now the masses must be educated to use this leisure in a worthy manner if we wish to progress collectively. At present every one has time to think, but the millions prefer the movies.

Isolation breeds distrust and differences of outlook. In annihilating distance and bringing the world and its peoples closer together the chemist is clearing the way toward lasting peace and good-will. Radio, telephone, and cable have tightened the bonds of understanding about the world. Airplane and airship have power to increase intimacy, understanding, and far-flung friendships, thereby enriching the lives, not only of individuals but of nations.

The importance of pure research, *i. e.*, the pursuit of knowledge for its own sake, without regard for its immediate or future value, must not be overlooked. Theoretical chemistry must advance at all times, for upon the development of theory, the revelation of new laws, depends the progress of applied chemistry. Practical discoveries and inventions always follow theoretical development.

Mendeléeff's system has been of great value in predicting the discovery of new elements. The existence and properties of scandium, gallium, and germanium were predicted when those elements were as yet unknown. In the adjustment and revision of atomic weights and the development of a systematic study of the elements the periodic law has been of great service. The classification of the elements by atomic numbers was another step forward in theoretical chemistry.

Becquerel's half-accidental discovery of the radioactivity of uranium compounds led to investigations which have marked an important era in the history of chemistry. In adopting the explanation of radioactivity we have abandoned the idea that an atom is an unchangeable thing. We know that new elements are produced from old by atomic decomposition. As the research of the theoretical chemist continues who knows how soon the tremendous energy of the atom may be made available?

"The future of our civilization depends upon the widening spread and deepening hold of the scientific habit of mind," said Professor John Dewey. Essential to a scientific spirit is a temper of mind which seeks for conclusions, but does not jump at them. Vision, a trained intelligence, and an open mind are qualities which must characterize the average

man of the future if we are to make the most of the destiny within us. When these qualities will have become common attributes, war and its attendant waste and misery will have vanished. Inability to see a situation from another's viewpoint will be replaced by a new tolerance, a new understanding. Scientific education will make the man of the future fully aware of the fearful possibilities of the use of scientific discoveries for other than constructive purposes. The search for knowledge will weld all men into a common brotherhood without race or caste distinctions. "As lantern-bearers, it is the clear duty of the men of science to show the way."

Over two hundred years ago Sir Isaac Newton said, "I seem to have been only a boy playing on the seashore and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great Ocean of Truth lay all undiscovered before me." Vast progress has been made since Newton conceived of the existence of invariable natural laws, yet today the student realizes, with even deeper humility, that the "Ocean of Truth" remains obscured by the fog of our comparative ignorance. Occasionally we obtain a glimpse of small tracts of water, but we know that the truth yet to be discovered so far exceeds that which we now have, that comparisons are useless. We are, however, stimulated to greater efforts, inspired by the possibilities which a chance discovery may have; we know that *law* is the supreme gospel of this universe and of all universes; we seek to understand those laws in order that we may realize the significance and the underlying harmony of the world in which we live, "to the end that all undertakings may be better ordered, all lives enriched, all spirits fortified."

Weight of Chemicals. Recent correspondence between a research laboratory and one of the American agents for Kahlbaum's reagent chemicals has brought out the interesting statement that those who purchase these imported chemicals are expected to accept them in the condition in which they are shipped from abroad. This means that, irrespective of the weights stated on the package, the quantities actually delivered must be considered satisfactory by the purchaser.

On three items the following data were secured: isobutyl alcohol, labeled and charged 500 grams, received 489 grams; normal propyl bromide, labeled and charged 5 tubes, 25 grams each, found to contain, respectively, 24.3, 21.6, 23.4, 24.9, and 23.2 grams. With many items, especially of volatile materials, such as alkyl halides, some losses may be expected, but when a shortage of an expensive material reaches 15 per cent it would seem to be a matter worthy of adjustment.

It appears, however, that purchasers are expected to accept packages, and not actual weights, although they are charged by weight. They should bear this in mind when purchasing Kahlbaum's reagents.—*News Ed., Ind. Eng. Chem.*, **7**, No. 11, 8 (June 10, 1929).

THE RELATION OF CHEMISTRY TO AGRICULTURE*

Guinevere Crouch, Boise High School, Boise, Idaho

Read the platforms on which Smith and Hoover so determinedly stood. Read the speeches given by these men in the last presidential campaign. You will find that farm relief was one of the strongest if not the strongest point at issue. The farmer is promised relief from these economic conditions which he can neither foresee nor control. It has always been thus from Lincoln's time right up to the present time of President-elect Hoover. But this sort of farm relief commonly means price-fixing by the government, a guarantee that the farmer will receive what his labor and product are worth. This must be carried out on an economically sound basis and therefore must not burden taxpayers with the payment of a disguised subsidy to farmers. Because this is not an easy thing to do, these promises do not mature.

Guinevere Crouch

The most effective aid in any instance is to remove the cause of the suffering. What is the reason for the present bad conditions of agriculture? A satisfactory market cannot be obtained, resulting in a surplus which is wasteful. How may this be remedied? Herein the agricultural chemist takes the leading rôle.

In the first place the food products raised must be as perfect as possible in order to receive the best prices. The condition of the soil is largely responsible for the success or failure of a crop.

Out of all the known elements only thirteen are necessary for plant growth. They are hydrogen, oxygen, nitrogen, and chlorine of the gases, potassium, magnesium, sodium, calcium, and iron of the metals, and carbon, phosphorus, sulfur, and silicon—non-metallic solids. Hydrogen, oxygen, and carbon are obtainable from the air and water. The others are dissolved in soil water in the form of salts, and under ordinary con-

* Prize-winning high-school essay, 1928–29.

ditions the majority of these are easily supplied; however this is not the case with nitrogen, potassium, and phosphorus, which very often have to be replaced by fertilizers.

Due to the ignorance of our ancestors, the soil has been robbed of many of its necessary elements by failure to replace those taken away from the soil in plants and by the burning of trees for the leaching of the ashes. The successful farmer should be instructed by the agricultural chemist whether his fertility account is properly balanced, so that these losses may be restored. The better use of green manures and plant residues, the conservation of animal manures, and the rotation of leguminous plants with the maintenance of soils in a condition suitable for the growth of these nitrogen-fixing organisms will all contribute toward keeping the soil fertile. However, there will still be need for further application after all these resources have been used to the fullest extent. This is accomplished by the use of chemical fertilizers. Nitrogen may be supplied to the soils lacking in this material by use of ammonium sulfate, given off as a by-product from gas and coke plants, sodium nitrate found in Chile, and from various nitrogen products obtained from the air.

Though the need of nitrogen fixation from the air, because of the possible exhaustibility of ammonium sulfate and sodium nitrate together with the high cost of Chilean nitrate, has been known for nearly thirty years, the World War furnished the real impetus.

The three most outstanding processes of nitrogen fixation are the arc, cyanamide, and direct synthetic—this latter being based upon the Haber process first developed in Germany. The arc process necessitates a great amount of power, and therefore is only practical where power is cheap. The cyanamide process uses only about one-fourth the amount of power per unit of nitrogen of that required for the arc process; however, if it is to be successfully operated, it also demands cheap power. In the direct synthetic-ammonia process power causes very little concern. As the product, ammonia, of the direct synthetic process can be easily converted into a compound suitable for fertilizer, and because it uses only one-fourth as much power as the cyanamide process, the arc and cyanamide processes are gradually giving way to the direct synthetic process.

There are three important sources of commercial potassium, the German and French mines, the salts recovered from evaporation of sea water, and wood ashes. There is as much potash in the rocks as nitrogen in the air, but the nitrogen is uncombined, while the potash is combined with silicon and alumina from which it is very hard to be separated. Potash is also given off as a by-product in cement, alcohol, sugar, and blast furnace industries. However, all these potash by-products could furnish only fifteen per cent of our needs. Some potash deposits have been found in Nebraska, Utah, California, and other states, but it can neither be easily nor cheaply

separated from the other elements. Thus we see that the bulk of our potash is still being imported.

Soils deficient in phosphorus may be enriched by the application of three substances—fine-ground natural rock, acid phosphate, and double super-phosphate. Although the United States has not the monopoly on phosphorus that Chile has on nitrogen and Germany on potash, we need not worry about our need of these products, as some of the world's most important deposits are found in Tennessee, South Carolina, Florida, Arkansas, and Kentucky. Large deposits of the rock were also found in the western states, Utah, Idaho, and Wyoming.

In many cases the unproductiveness of a soil is due not to an absence of any particular element but to an injurious excess of acid, alkali salt, or some other substance. The acid in the soil may be neutralized by the application of lime. Excess of alkali may be prevented by irrigation and drainage or use of gypsum.

The chemists are now working to develop more efficient fertilizers in concentrated forms, eliminating a great amount of the shipping cost. If in the future phosphoric acid may be obtained more cheaply, a salt, ammonium phosphate containing both nitrogen and phosphorus in a highly concentrated form, would be obtained by directly combining phosphorus acid with ammonia. There are various other nitrogen, phosphorus, and potassium compounds which may be combined in varying amounts to form a more efficient fertilizer.

It is evident that in time to come, due to the widening use of fertilizers and the decreasing of present sources of these products they will be manufactured on a strictly chemical basis. However, there are various difficulties which must be overcome. Not only must a plan be worked out for the manufacture of ammonia and phosphoric acid so cheaply that they could compete with the present sources of nitrogen, but the farmer must be educated in the use of these new methods before they can come into wide use.

By this brief survey of the soil it can easily be seen that by the application of certain chemical fertilizers in the correct proportions found by chemical analysis chemistry is certainly now solving the problem of soil fertility and will continue to in the future.

The chemist's work does not end with making it possible for the farmer to have his soil in perfect condition, but also protects the plant after it has begun to grow against various diseases, insects, microbes, and fungi. Price-fixing by Congress could not possibly have any effect on the workings of these little organisms, but chemistry certainly has.

The yearly losses caused by the cotton boll weevil have been estimated to exceed $300,000,000. Calcium arsenate has been found to be a valuable insecticide for this and is now scattered by airplane. This means of appli-

cation, however, is often wasteful, and it remains with the chemist to devise a plan by which this may be scattered without the present waste.

Forms of sulfur were the only chemical sprays known to the ancients. Cato has written about these. As with fertilizers so with sprays. It was left to the modern chemist to find the real reasons for the actions of certain materials and to discover new and more efficient ways. Bordeaux mixture is used as an effective fungicide on potatoes, tomatoes, and other crops. With the great increase of San José scale in the Middle West, interest was revived in lubricating oil sprays, and several simplified formulas for their manufacture have appeared.

The use of a trap crop to collect insects where they can be killed without loss to the main crop is a common farm practice. The chemists found that this attraction was due to some volatile substance in the plant. If this could be separated and synthesized, its use in combination with the poison would furnish a very effective means by which the insect would be lured to its own death. Amyl acetate has been used in this way for the destruction of grasshoppers, geraniol for attracting the Japanese beetle, and trimethylamine for the cotton boll weevil. Hydrocyanic acid and other volatile poisons have been used to combat scale upon fruit trees and weevils in stored cereal products.

To perfect these insecticides, fungicides, and sprays so that they will be more efficient, cheaper, and less dangerous to both plant and consumer is a feat which will necessitate the highest chemical knowledge.

The damage to agricultural products caused by the attack of certain microbes opens a wide field for investigation. Souring of milk, rotting of fruit and timber, and swelling of canned goods are examples. The chemical action of these processes is very imperfectly understood, and the chemist must study these changes and provide a means by which they may be prevented. Not all the work of these micro-organisms, however, is detrimental. Bacteria and yeasts, when properly controlled, are exceedingly useful to the farmer. Cheese, vinegar, sauerkraut are valuable products resulting from their work.

Quack grass—with the exception of the Canadian thistle, the most destructive weed known—has in recent experiments been successfully killed, roots and all, by the use of the chemical, sodium chlorate. This is indeed a very important discovery, as many of the richest soils in Northern and Eastern United States are now so overrun with the weed that cultivation is almost impossible. This idea of killing weeds with chemicals is old, but heretofore none has been found that is not injurious to the soil.

Losses through insufficient fertilization, diseases, insects, and fungi are by no means the only farm losses. The problem of surplus is doubtlessly the most important agricultural enigma of the present day. Here again the chemist is solving the problem.

The farmer has heretofore paid attention only to the production of crops for net weight in making food products and clothing. Now through breeding experiments and constant chemical supervision he is providing his growing plants with the necessary amount of raw materials which will make possible a maximum yield of the desired product whether it is starch, cellulose, oil, protein, or any other substance.

According to Professor O. R. Sweeney of Iowa State College, some 3000 known industrial products can be made from cornstalks, oat chaff, cottonseed hulls, peanut shells, and straw. Wall board is made from sugar cane bagasse. Sixteen million tons, the yearly waste of cornstalks, may be converted into 8,000,000 tons of paper. Corn has been used in the manufacture of starch, dextrin, glucose, sirup, dextrose, gluten, oil, and cattle feed.

There is also the possibility of converting straw into tar, illuminating gas, acetic acid, wood alcohol, xylose, furfural, oxalic acid, strawboard, and lumber. The utilization of unmarketable lemons has been accomplished by the manufacture of citric acid, lemon oil, marmalade, cattle feed, and pectin. Oil from the cottonseed, once a problem, now is a very profitable product.

These are only a few of the many that might be mentioned. It can be truthfully said that not nearly all the possibilities of chemical utilization of our crops have yet been realized.

Not nearly all the farm products grow from the soil. Indeed the farm animals play a great part in agriculture. Here also we see the need of chemical aid. As new kinds of machinery are rapidly taking the place of horses and oxen for work on farm, the feeding of animals for production of milk and meat rather than work has become the practice. Therefore, feeding materials must be investigated in order to find the best growth-producing kinds of proteins.

In the old days a certain amount of carbohydrates, fat, proteins, and mineral matter was thought to be sufficient for an animal. But as a result of investigation, it has been found that not all proteins are alike in tissue building.

It was also formerly thought that no other minerals were needed besides salt and calcium phosphate. We now know that this is not true and that it is necessary to balance the acid-forming with the base-forming elements in the diet. According to Henry P. Armsby, Founder and First Director of the Pennsylvania State College Institute of Animal Nutrition, the difference between the energy value before consuming and that lost in utilization represents the net energy value of a food.

Iodine has been introduced to prevent goiter in animals raised where the soil is deficient in iodine. It has been found that the iodine taken up by cereal crops is lodged in the germ of the grain. This hitherto re-

jected portion of the cereal may come into wide use as a feeding material, as it contains not only iodine but organic phosphorus, vitamins, and other foods.

We see now that soil fertility is maintained by the aid of chemicals and plants protected by application of chemicals. Therefore, if the farmer will have good crops, he is dependent on chemistry. Due to the fact that we cannot possibly consume all the farm production as food, it has become necessary to devise plans by which there would be no waste. This chemistry has done. The investigation of chemists on food rations for farm animals has told the farmer what foods he can most profitably and with the best results feed to his animals.

I believe that in the future the bulk of our food will continue to be raised from the soil, but I also believe that the farmer of the future will not confine himself so closely to food production as formerly. Real farm relief will be secured when the factory and farm coöperate in carrying on great industries. The agricultural chemist has already laid the foundation of many new and rich industries.

The general nation-wide belief is that agriculture is doomed to die or is now dying a pitiful death. On the contrary, I believe, after seeing all the things chemistry has done and may in the future do for farming, that agriculture is now just establishing itself upon a sound and profitable basis as other industries.

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THE RELATION OF CHEMISTRY TO NATIONAL DEFENSE*

Amaziah Parker Smith, Chapel Hill High School, Chapel Hill, North Carolina

All major nations are bringing to bear upon the problems of national offense and defense, of supplies of foods and other necessities, upon the preparation and preservation of their man power, all the vast resources of scientific knowledge and research which the last hundred years have given to our civilization. Nearly all the sciences have been called upon to render important service, but it is not surprising that the leading rôles have fallen to the two fundamental natural sciences—physics, the science of the transformation of energy, and chemistry, the science of the transformation of matter.

Amaziah Parker Smith

Of these two sciences, chemistry is the most universal today and the most necessary to progress. To the physicists chemistry has supplied, as needed, indispensable materials, without which their brilliant achievements in war would have been in large part impossible. The keenness and accuracy of vision of the modern rangefinders, of telescopes, field-glasses, and cameras—the eyes with which physics has equipped modern armies and fleets on the sea and in the air—depend on the preparation by the chemist of optical glasses of purest quality and fine adjustment in composition to a great variety of needs.

Again, the modern airplane would collapse under its load of pilot and observer, of armor and ammunition, did not chemists supply those cunningly devised alloys which combine greatest strength and toughness with a minimum of weight. In fact, every single component of the airplane and its equipment has been made the subject of intensive chemical study, designed to meet the new conditions of strength and lightness, power and compactness, resistance to vibration and to the moisture of the clouds and the frigid-

* Prize-winning high-school essay, 1928–29.

ity of the skies. The fuel of the engine, the lubricant of its parts, the metal of the engine and of the framework, and the material of the wings and of their coating are chemical problems, still engaging the attention of investigators who would improve this vital weapon of the air. Even the instruments on the instrument board of the modern airplane are made visible at night by means of two chemicals—radium or an equivalent, and zinc sulfide.

Before the invention of the airplane, chemistry gave to aviation a gas which made possible the observation balloons and zeppelins. This gas, hydrogen, was used extensively in aviation but was supplanted by a superior gas, helium, which today is being used in transatlantic flights. The utility of these gases in future warfare is at the present incomprehensible.

Medicine does wonders in protecting the millions of men in arms against disease in camp and trench, which in early wars was prone to count more victims than did the battlefield. To medicine chemistry gives its antiseptics and disinfectants, iodine, phenol, bichloride of mercury, and many other useful compounds. During a war chemistry must contribute on a gigantic scale the anesthetics for the operating tables of the base hospitals, which are at no other time demanded in such great quantities.

In the face of the fast disappearing margin of safety in the food supplies of the world, final success or failure of belligerents may rest with the botanist, under whose guidance should be placed the effort to produce a maximum yield of food despite a shortage of men. To this vital campaign chemistry gives the lore of the composition of the soil, the formulas for effective fertilization with potash, phosphate, nitrate, or ammonia, in order to make possible intensive soil cultivation. It is no exaggeration to say that German chemists, by the aid they rendered agriculture in supplying it with the thousands of tons of ammonium sulfate and nitrate prepared from the atmosphere, saved their country in an early period of the World War from the alternative of starvation or surrender. When parasites threaten the growing crops or a blight attacks the garnered grain, fruit, or vegetable, it is again to the chemist that the botanist must turn for his cyanides and arsenicals, copper salts, and sulfur mixtures. Finally the efforts of the botanist in control of agriculture must be supplemented by the chemist in perfecting methods of preservation, and especially of desiccation of foods, which in one operation could relieve difficulties of transportation, of storage, and of preservation.

It is no exaggeration to say that chemistry made the World War possible in its very beginning and was primarily responsible for the prolongation of its terrible ravages. There is no question that without the development by her great chemists, especially by Professor Haber, Professor Ostwald, and Dr. Caro, of methods of converting the atmospheric nitrogen on a large scale into ammonia and nitric acid, Germany would not have dared to open

the war in 1914. It was these discoveries that insured to her, for an indefinite length of time, ample and constant supplies both of explosives for the battlefields and of fertilizers for her farms. The Haber process alone has been estimated to have produced in 1917 no less than 500,000 tons of ammonium sulfate as against a yield of 60,000 tons in 1914, and the total yield of nitrogen products obtained from the air in Germany in 1917 has been estimated at 1,600,000 metric tons. Without this aid, in the face of the possibility of Great Britain's control of the seas and the cutting off of supplies of niter and food, Germany would have been compelled to stake all on the chance of a speedy conquest, such as she failed to achieve in 1914, as a result of the Battle of the Marne.

With chemistry such a vital factor in the very inception and planning of a war, it is not a matter of surprise to find in its progress that the power and resourcefulness of the science of the transformation of matter should have been drawn into the conflicts to an ever increasing degree, until at last we had chemists at the very battle front waging war on a scale never witnessed before in history. At the end of the World War, we find that it was fifty per cent chemical.

In chemistry "behind the lines," we find our great steel industries meeting a demand for steel for guns and shells, for ships and armor, for the innumerable accessories in buildings, railway equipment, and machines, a demand greater than at any time in the history of the world; for the steel industry is simply our greatest chemical industry, consisting of a series of chemical operations carried out on a huge scale. From the assaying of the ore at the mouth of the mine and in the yards of the mills, from the regulation of the coking oven and the closest inquiry into the composition of every ingredient mixed with the ore in the furnaces or with the crude iron, through the supervision of manufacture by specimens drawn off and sent to the chemical laboratory for rapid tests, to the final stages of its purification, steel is the product of chemical control and investigation. The chemist's knowledge of how the properties of steel can be modified as to toughness or hardness, elasticity, temper, and resistance to heat and to cold through the cunning admixture of other components, has been used as never before to give a longer life to great guns, to add to the resistance of armor, to preserve the cutting edge of high-speed tools, working without loss of efficiency at temperatures at which ordinary steel would melt.

Side by side with steel stand the explosives for the millions of shells we make. Thus the best of modern explosives, trinitrotoluene, is manufactured from toluene with the aid of nitric and sulfuric acids at the rate of many tons per day. The power of this explosive was never shown in a more tragic and overwhelming manner than in the destruction of Halifax, which was brought about by the explosion of a cargo of trinitrotoluene in the harbor. Other high-power explosives, picric acid, gun cotton, nitro-

glycerin, and nitrogelatin, are manufactured on a colossal scale under the direction of expert chemists. Let the compounding go a bit too fast and temperature control be lost, then the giant powers inevitably pass from the control of man, whose only safety lies in flight from the approaching upheaval.

Upon the chemist also falls the duty of insuring a constant stream of supply of the basic materials from which these high explosives are made. The manufacture of sulfuric acid is in itself a vast industry, working at its utmost capacity and seeking every available source of its own crude material, sulfur. For the production of nitric acid we were once dependent on the nitrates of Chile and Peru, but eventually our government erected plants for the production of nitric acid from the atmosphere. Similar factories in Germany, as I have already said, kept her supplied with this absolutely necessary material, without which she could not have faced the possibility of a prolonged war.

The part which chemistry plays in the battle line itself is perhaps the most interesting and absorbing chapter in the history of war so far as it is written by chemists. When Germany, in 1915, let go the first wave of poison gas in contravention of all international agreements, it is said that the British general in command wired to London that if relief were not sent within three days the whole British line would be compelled to retire. This is a measure of the suffering of the first victims of this mode of attack, which was justified in the eyes of the German public only by the claim that the French had first used chemical "stinkpots." To the credit of the coordination of science and government in England, it has been reported that within thirty-six hours a million and a half of the first crude but sufficiently effective gas masks were delivered at the front—simple gauze affairs saturated with absorbent for the much dreaded chlorine gas of the enemy.

Since that day chemical warfare has rapidly developed, offensively and defensively. At first it was simply a matter of a "gas wave" propelled by the wind and rolling over the land from trench to trench; but this mode of attack was too dependent on the whims of the shifting winds, and chemical warfare very soon had recourse to the hurling of shells loaded either with a deadly poison or with irritants for the eyes and all exposed mucous membranes. Most dreaded of all, however, is the last form of chemical attack, the attack by liquid fire, against which there is no defense except speedy flight and the fact that the attackers in flame warfare are usually easily detected and rapidly "picked off."

Even if I could, it is best on the whole not to name the materials used in this business. A few of the facts, nevertheless, concerning the materials used in chemical warfare have already received such wide dissemination that they may be mentioned here. Chlorine was the first gas used, a violent irritant for all mucous membranes and especially for the lungs, as

every student in chemistry has experienced at some time or other. Chlorine is commonly employed both for gas waves and in bombs charged with the liquefied gas under high pressure. Even more terrible than chlorine is phosgene, a combination of chlorine with that other deadly gas, carbon monoxide, which is produced in a coal or charcoal stove when the glowing coal has an insufficient supply of air for complete combustion. The specific gravity of phosgene is greater than that of chlorine, and it has been largely used, often mixed with lighter and more poisonous gases, for the gas wave attack under the favor of the winds. Even a single whiff is oppressive to the lungs for a day. It is better to say nothing about the nature of the ingredients carried by shells intended to scatter poison or irritant among the ranks of the enemy. Some of them are so deadly that two small whiffs are sufficient to cause death, others so irritating that they are blinding or cause such edema of the lungs that men are totally incapacitated.

Against this offensive chemical warfare, after the first surprise attack, effective defense was developed by masks containing suitable absorbents for the purification of the air inhaled. The most important quality which a good mask must have is to absorb a great variety of poisons with a speed which will allow the working soldier to inhale at least thirty liters of air per minute. Chemical officers in camps teach our men, by object lessons with some of the materials they are likely to encounter at the front, that the gas mask, uncomfortable as it no doubt must be, is the very best friend a man in the trenches can have.

Within the last few years we have seen the absolute triumph of the most scientific nations over the savage, through the development of chemical warfare. No longer can an uprising in any country on the globe amount to anything unless those in control of it are supplied with the necessary chemical warfare materials. It may be said that chemical warfare materials have made defense of the homeland cheaper and easier because the most expensive forms of armament are those most readily visible. Particularly is this true of a country separated from other powerful countries by water. With the realization of this power of defense has come also the realization that great military power in the future will be measured far less by numbers of soldiers than in the past. The nation which has a coal supply sufficient to furnish power and coal tar products can make all the high explosives and war gases needed, or that can be used by any nation. With the development of chemical warfare she can with comparatively small numbers of men defend her shores against any enemy.

With chemists needed everywhere for the battle line itself as well as for the key positions in the vast industries behind the line which supply munitions to our armies, our country has cause to congratulate itself that there is one important article which some thirty-five years ago it was wont to import from Germany, but which it fortunately learned in good time to pro-

duce for itself, both in the very best quality and goodly quantity. That article is the American chemist.

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ASSISTANT TECHNICAL DIRECTOR (CHIEF CHEMIST) TO BE APPOINTED IN CHEMICAL WARFARE SERVICE, EDGEWOOD ARSENAL, MD.

Civil-Service Commission Announces Method of Selection

The United States Civil-Service Commission states that the position of assistant technical director (chief chemist), Chemical Warfare Service, Edgewood Arsenal, Md., is vacant, and that in view of the importance of this position in the field of chemical research, the method of competition will be as follows:

Instead of the usual form of civil-service examination, the qualifications of candidates will be passed upon by a special board of examiners composed of H. E. Howe, Editor, *Industrial and Engineering Chemistry;* H. L. Gilchrist, Chief of Chemical Warfare Service; and A. S. Ernest, Examiner of the U. S. Civil-Service Commission, who will act as chairman of the committee. For the purposes of this examination all of these men will be examiners of the Civil-Service Commission.

As assistant technical director, this employee has direct supervision of all research and development work and is responsible to the technical director. This involves planning, coördinating and checking the technical and scientific work of the several technical divisions, and advising the technical director and division chiefs as to the best methods of attacking and solving the scientific and technical problems with which they are confronted. It also involves a careful review of all current work as reported in the monthly, annual, and final reports of the technical divisions with a view to determining the actual accomplishments and scientific value of the work. It further involves a survey and analysis of the past work of the technical divisions with a view to evaluating this work and determining whether all profitable lines of research have been consistently followed up; whether any work is now being done which is a duplication of work previously accomplished; and whether the results to date indicate a necessity for investigations which are now in progress. In addition, the assistant technical director will have such administrative and executive duties as may be assigned to him by the technical director.

As chief chemist of the Chemical Warfare Service, this employee advises the Chief of the Chemical Warfare Service on such technical and scientific matters as may be referred to him.

The salary range for this position is from $8000 to $9000 a year.

Formal applications will be received by the Civil-Service Commission until August 28th.

Full information may be obtained by communicating with the United States Civil-Service Commission, Washington, D. C.

THE RELATION OF CHEMISTRY TO THE HOME*

Morgan L. Walters, Rock Springs High School, Rock Springs, Wyoming

We live in an age of chemistry. Practically everything that surrounds us in our life today, whether associated with our homes or our occupations, our necessities or our luxuries, can be traced to the work of the chemist. There is no art or industry of modern civilization which does not require the constant aid of chemistry. The average person today accepts as a matter of course the various contributions to his comforts by men of science. Day after day we continue to use the comforts and conveniences with which chemistry has supplied us, not thinking of all the toil and hardships which were necessary before they came into existence.

Morgan L. Walters

Alchemy, which flourished in the Middle Ages, was the forerunner of our present-day chemistry. The chief objects of all alchemists were to discover the "philosopher's stone," which would increase the wealth of the world by inexpensive manufacturing of gold, and to obtain an elixir which could cure all diseases and thereby indefinitely prolong human life. The alchemist failed in these two objects, but many years later, the chemist, by dint of much patience and extensive research work, has, to a certain degree, indirectly accomplished what his forerunner failed to do.

It is in the practical applications of his findings that the chemist has made the world his debtor. So numerous are those applications that the mere naming of them would be a great task and the list too long. Even the relation of chemistry to the home furnishes material for volumes.

In the home, the influence of chemistry is universally present. Wherever we turn, and whatever we use, it directly or indirectly affects us. In a short treatise like this, only a few of the more important facts concerning

* Prize-winning high-school essay, 1928–29.

the relation of chemistry to the home can be given, namely: the relation of chemistry to life's three essentials, food, clothing, and shelter—the foundation of the home.

Food is the first essential of the home. In primitive times man's only thought was that he should obtain food. From sunrise till sunset he was busily occupied in hunting game or picking fruits, that he might eat and enjoy life. At the present time we are not wholly concerned with food-getting; we enjoy life to a much greater extent, owing to the achievements of the chemist in this phase of our home life. But we must go back to the very source of our food—the soil from which the plants take their nourishment. The agriculturist was entirely ignorant of the needs of plants until the ever-obliging chemist undertook to discover the food of plants. He found that all plants are dependent for life upon potassium, phosphorus, and nitrogen, which nature cannot sufficiently supply to meet the demands of the growing plants. The chemist taught the manufacturers of commercial fertilizers how to produce these cheaply and in large quantities to meet the demand of the particular crop to which they are to be applied.

On making further inquiries the chemist found that food is oxidized in the body (a chemical process) and energy is given off by means of which the processes of life are carried on. Two chemists, Atwater and Fischer, especially, have been working on this subject, their discoveries earning for them world-wide reputations as experts in this line of chemistry. With the introduction of energy values of food, by professors Atwater and Fischer, came the formulation of the theories of nutrition, which now enable us to prepare a balanced diet with the maximum nutritive value at minimum cost. The struggle to discover all the factors which go to make up a balanced diet has been very long and severe requiring the undivided attention of these chemists for many years. Good nutrition is a great factor in health and happiness of the home.

The attention of the chemist toward food, however, did not terminate at this point. Funk, McCollum, Eddy, Steenbock, and Goldberger are famous for their finding of vitamins, which are now known to be essential to life. These scientists have told us that some foods are more nutritive and contain more vitamins when eaten uncooked, while others are not harmed by heat, and still others must be cooked in order to liberate or transform certain elements to render them fit for tissue building. Such diseases as scurvy, beriberi, and pellagra have been for the most part eliminated by the presence of these vitamins in the daily diet. Milk, called the perfect food by the chemist, contains vitamins A, B, C, and D in great abundance in addition to the proteins, carbohydrates, and fats, which are all needed for the up-keep of the human machine. Thus the slogan of a quart of milk a day for the growing child is good advice. The vitamin discovery came at the right time, for our diet had drifted

farther and farther away from the natural and fresh foods of our ancestors.

Another triumph of chemistry for the home is the preservation of foods, which goes hand in hand with the theories of nutrition; for it has enabled us to have a varied diet at all times, no matter what time of the year or how far distant we are from the point of production. Canning, which was discovered in the nineteenth century by Appert, a Frenchman, is the most common form of the preservation of foods. The food is first parboiled, and while yet hot the can is sealed, thereby excluding all venturesome bacteria. In this form the foods can be kept indefinitely. Canned vegetables, fruits, and meats tend to eliminate labor on the part of the housewife. The preservation of foods naturally brings to our minds the name of one of the greatest chemists the world has ever known—Louis Pasteur. His greatest contribution was pasteurization—the preservation of milk. Pasteurized milk is heated from one hundred forty to one hundred fifty degrees Fahrenheit, a temperature which kills all harmful bacteria. The consumer, therefore, owes his assurance of purity of his milk to chemistry.

The scientists were not satisfied with these more lasting methods of preservation, and have successfully endeavored to bring forth some means of preserving food for several days. Among these devices is the electric refrigerator. The electric refrigerator is run by an electric motor, which, by the aid of pressure, liquefies sulfur dioxide gas. This liquid runs through a succession of coils, which surround a tank of brine. Through the process of evaporation sulfur dioxide cools the tank of brine sufficiently to freeze water, placed in small containers within the brine. A thermostat regulates the temperature of the refrigerator keeping it constant at all times. Constant temperature keeps the food from spoiling, and assures us that there will be no possibility of food poisoning.

In some localities electricity is very expensive; so the ever practical chemist has made "dry ice," which is now replacing water ice especially in long distance shipping, and is fifteen times as efficient as water ice. Dry ice is made by solidifying carbon dioxide gas. The temperature of solid carbon dioxide gas is from one hundred ten to one hundred fourteen degrees below zero Fahrenheit. This ice when melting gives off a heavy gas, that settles around the ice, pushing the warmer air upward, thus lengthening the life of the ice.

The chemist is a protector as well as a giver. Many manufacturers adulterate their food products with such chemicals as salicylic acid, sodium benzoate, sodium sulfide, formaldehyde, and saccharin, which are commonly called adulterants. Since the chemist knows that such adulterations will seriously impair the digestive system, he has caused to be framed and passed the pure food laws, which prevent the adulteration of foods by the manufacturer. Even with this law in effect, unscrupulous manufac-

turers fail to comply with its rules; so every state has a staff of expert chemists who test all food products before they are put on the market.

The pots and pans in which the modern housewife prepares her foods undergo chemical operation before they are placed in her possession. Aluminum utensils cost us little—we may get them for a few cents at a bargain sale. But before Charles Hall isolated aluminum it would have taken a fortune to buy an aluminum pot.

In the home the housewife must contend with uncleanliness. This she does with the aid of chemistry, which supplies her with various scouring powders, polishers, and soaps. Soap is by far the most important of all. "Life was worth while in the good old days," people used to say. But no more. For they realize that they cannot compare a dark and filthy building of the olden days with the modern, sanitary home. Soap is formed by a chemical process—the action of a caustic alkali on a fatty oil. Lye, which is a very strong alkali used in removing grease spots or to clean out the sink, is chemically prepared. The washing powders we use on our linoleum are all alkalies; and even the linoleum is a product of the chemist's art, since it is chemically formed from ground cork and linseed oil.

Sanitation in the home is further aided by the use of disinfectants, which are becoming more and more familiar to us. Flavine, phenol, and lysol are disinfectants made from coal tar. Formaldehyde, sulfur dioxide, and bleaching powders are common compounds used as fumigators in the home. Through the application of chemical research, another disinfectant, a new aldehyde, furfural, has been obtained.

Aside from its relation to food and cleanliness, chemistry has created textiles, which we use for clothing and furnishings. The chemist has discovered that cotton is a social climber. Handicapped by its lack of the sheen of silk or the luster of linen or the warmth of wool, it is now gaining upon its rivals by aid of the chemist.

John Mercer, an English chemist, found that when cotton was dipped into sodium hydroxide and not allowed to shrink, the hydroxide took the kinks out of the cotton, softened its surface, increased the tensile strength, and gave it something of the luster of silk. This is called mercerized cotton in the commercial world today. Should the chemist dissolve cotton completely in alkali sulfide, nitric or acetic acid, and spin out the viscous fluid into threads, he would produce a synthetic fiber that closely simulates silk in appearance and strength, which is sold under the trade name, rayon. Fifty per cent of what seems to be silk nowadays comes from the chemical laboratory instead of from the cocoon. Thus the chemist is an ally to King Cotton.

Charles Schwartz, a Swiss chemist, discovered that if cotton was immersed in concentrated nitric acid, the fibers became more curly, their

surface rougher, and the fabric assumes the texture of a new material to sight and touch. In wear, warmth, and appearance this cloth resembles wool. The yellow tinge may be removed by bleaching, a chemical process. When this woolen fiber is mercerized it looks like linen, and is said to dye more readily and brilliantly than untreated cotton. The chemist has given us these artificial textiles made from cotton fiber which are more economical than the genuine product, but which serve the same practical purpose. Even net and lace which formerly were made by manual labor, can now be manufactured by machine, because of the discovery by the chemist of a solvent for cellulose. Artificial rubber has been prepared by chemical means. Leather, which is made from the hides of animals by a chemical process, can now be manufactured from cotton or wood-pulp, ether, and alcohol.

As you walk down the street you are aware of the great variety of colors in the clothing of the passersby. How many are aware that here chemistry has made one of her greatest contributions? A few years ago nearly all dyes were extracted from plants, and besides being dull they were rare and expensive. Chemistry brought about a radical change in existing conditions. It was William Henry Perkin, another chemist, who prepared the first dye from coal tar, a product of coal which was in former times considered a nuisance, being very hard to get rid of and clogging our sewer pipes. Now it is considered a blessing to man. The preparation of others soon followed, until today thousands of these dyes of every variety of color are manufactured. Some of these dyes are produced by exceedingly complex processes in which a large number of separate steps are required to produce the finished product. These aniline or coal-tar dyes have almost entirely superseded the old vegetable dyes. The coloring of textiles, rubber, leather, and other materials has become a much more inexpensive process.

Chemistry is very important in its relation to the last essential of the home, shelter. The improvement of all materials entering into the building of our present-day houses is directly due to the work of the chemist. Our houses are not our homes, but they are the shells on which we build our homes.

Chemistry has amply supplied us with the most desirable kinds of materials for building these shells. Knowledge of the chemical actions which take place when mortar, cement, and concrete harden, and knowledge of the properties of the various irons and other metals, have brought about the present durability and beauty of home architecture. Our buildings are constructed so as to form one massive, indivisible structure. Our cottages have been made more durable through the use of the various plants which prevent oxidation and thus remove the tendency for the wood to decay. The electrolytic method of making white lead, recently introduced,

will greatly reduce the cost of white lead, which is the basis of all paints. The interior of our homes has been made pleasant and cheery by the glossy, pleasing presence of what we call coating or impregnating materials to insure durability. Some of these are varnish, shellac, lacquer, enamel, stain, and wax. A late achievement of the research chemist of this phase is Duco and Bakelite liquid products. The plumbing and toilet fixtures are likewise the chemist's handiwork. In fact, almost everything which pertains to the actual building of our home is made or personally supervised by the chemist.

With only a hasty glance at a few of the factors which appertain to the essentials of the home, one can see that the science of chemistry has exerted a great influence. This influence will continue to be felt with research chemists all over the world making new discoveries. It is certain that in the past the relation of chemistry to the home has been incalculably beneficial. Thus civilization owes a debt of great magnitude to the chemist. Nothing is more reaching in effect or more beneficial to the homes of mankind than chemistry.

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Horizontal Rainbows Due to Fine Water Droplets. Rainbows in the sky are familiar to everybody, but if you are fortunate enough, you may sometime be able to see a horizontal rainbow on a calm surface of water. You are most likely to see it following a fog, and if you are particularly fortunate, you may even see a cluster of several horizontal rainbows.

In a recent issue of the *Journal of the Franklin Institute*, Dr. W. J. Humphreys, professor of meteorological physics at the U. S. Weather Bureau at Washington, describes the formation of these strange phenomena, and tells of two people who have seen them in clusters. The bow seems to be right on the surface of the water, and in the case of the cluster, one appears right behind another.

The cause, says Dr. Humphreys, is a layer of tiny droplets of water, resting on the surface of the body of water, but prevented from merging into it by a thin film of oil on the surface. The sun is in back of the observer, and the rays of light are refracted back to the eye by the tiny droplets of water on the surface, just as they are by the drops of water in the sky in the case of the usual rainbow. If the sun is overhead, the horizontal bow appears as a circle. If lower, it is an ellipse, surrounding the observer. If at an angle of 42 degrees above the horizon, it is a parabola, while at a lower angle of sun it is a hyperbola. All of these curves are what the mathematician calls "conic sections," that is, the curves formed by the intersection of a plane with a cone.

The cluster of several bows is formed by reflections from the actual surface of the water, as the sheet of droplets may not be quite in contact with the water surface.—*Science Service*

THE RELATION OF CHEMISTRY TO THE ZINC INDUSTRY*

JOHN DOUGLAS MARTIN, JR., SOLDAN HIGH SCHOOL, ST. LOUIS, MISSOURI

The fundamental industries of yesterday, today, and tomorrow are and will continue to be the same; namely, fishing, agriculture, forestry, and mining. Ever since man came into being he has made himself the captain of these industries. He would catch fish; gather fruits, berries, and nuts; and build for himself some kind of shelter from the trees of the forest, using crude tools of stone garnered from the mineral deposits at hand.

Mining has felt the influence of man's hand for ages. However, it was not through any precise knowledge of chemistry that the ancients reduced various ores to the metallic state. They simply happened to make combinations of minerals and obtained results that were new to them. This haphazard method continued for centuries, until finally it was observed that under the same conditions certain combinations always produced the same results. By continued experimenting and research, the present-day chemical and metallurgical processes have developed.

JOHN DOUGLAS MARTIN, JR.

The relation of chemistry to the reduction of zinc ore is a most interesting phase of the application of that science to the development of a natural resource.

During the latter part of the eighteenth century, the first crude retort was made, and zinc distilled from minerals about which little was then known. This method of using a retort for extracting zinc from its ore has persisted and is used today—only, of course, with greatly improved methods of operation. It is only within recent years that a different method has been perfected by electrochemistry. It is the electrolytic process of extracting the metal zinc from its ore.

The electrolytic process of depositing metals from solutions has been in

* Prize-winning high-school essay, 1928–29.

use for many years. The process as applied to zinc has been perfected after a great amount of research in the preparation of the electrolyte. The ores usually contain elements other than zinc, which have to be eliminated; and to accomplish this requires an elaborate system of equipment. This system is actually a chemical laboratory on a large scale. The ore is weighed and placed in agitators, where the solvent, sulfuric acid, is added. Here the iron that may be present is precipitated. From this first set of agitators, a pulp, consisting of the zinc dissolved in the solvent, travels to a set of mechanically operated filters, where the solution containing the zinc filters through, leaving a cake or residue which is washed with water to remove the last traces of the zinc-bearing solution.

This residue is then put through a thickener, thence through another set of filters, and finally through a rotary drier, where enough moisture is removed to make the residue easy to handle for shipping. The values in this residue may consist of lead, gold, silver, and other metals, which are extracted at other smelting plants.

The zinc solution from the first set of filters enters another set of agitators. Zinc dust is added to the solution, and by agitating at 80°C. complete precipitation is obtained of what copper, cadmium, and cobalt may be present. Leaving these tanks, the solution is again filtered and stored in one of several "hold" tanks, where it remains until a final laboratory check determines whether it is in condition to enter the final storage tank, from which it is distributed to the electrolytic cells.

This solution, the electrolyte, is pumped into the electrolytic cells, where it surrounds two sets of electrodes. One set, made of a lead alloy, is connected to the positive pole of a generator; and the other set, made of sheet aluminum, is connected to the negative pole. When the electric current is passed through the electrolyte, the positive zinc ions are attracted to the aluminum cathode, where they give up their electric charge and are deposited as metallic zinc. When the aluminum cathode has a coating of zinc about three-sixteenths of an inch thick, it is withdrawn and the zinc stripped from it. This stripped zinc is then melted in a large pot furnace and molded into slabs for shipment. The zinc recovered by this process averages better than 99.99%. This almost chemically pure product has been made possible by a special research, the object of which was to reduce the loss of lead from the anodes to the electrolyte. Experiments were made with all elements that would alloy with lead. The alloy now used contains about 99% lead, the other constituents being kept a secret by the developers.

All the operations of the plant are carefully watched over by chemists who take numerous samples which are analyzed in order to determine whether the plant is functioning properly and efficiently. Sulfuric acid is a by-product here, as it is at a retort smelter.

To gain a good idea of the influence of chemistry on the distillation process of zinc recovery, let us start with the location of the zinc ore and follow it until the metallic zinc leaves the smelter.

A field party is on prospect, the chief of which has spent many hours in a chemical laboratory while preparing for his career as a mining engineer. The prospecting party, using a diamond core drill, will sink many holes into the earth, varying from a few feet to hundreds or even thousands of feet in depth. The drill is so constructed that it brings to the surface a core of the material through which it passes. A careful log of these cores is kept. Samples from them are analyzed in a chemical laboratory. Upon these analyses rests the decision as to whether a mine will be opened or not. If the report is favorable, development is started and eventually a mill is producing zinc blende.

As the ore comes from the mine it is sampled and assayed; possibly five or six per cent of zinc is found. The ore is ground, jigged, concentrated, and floated, until all the obtainable values are in the bin and the chats on the dump. All through the process, samples are taken and determinations are made in the laboratory to ascertain if the plant is recovering all the values from the raw ore.

In the Joplin-Miama district (southwest Missouri and northeast Oklahoma) the ore market is held on Saturday. Here thousands of tons of concentrates are sold on a basis of sixty per cent zinc content. During the following week this tonnage of ore is loaded for shipment to the smelters. After loading, a thorough sample is taken. This sample is divided into three parts—one for the seller, one for the buyer, and the third to be sealed and preserved for umpire. Any one of several commercial laboratories may receive the samples for assay. After determining the percentage of moisture present, they run them for zinc, lead, iron, and lime content.

If the buyer and seller samples do not differ more than five-tenths of one per cent in zinc, a split settlement is made. If the difference is greater, the umpire sample is run by still another laboratory and a settlement is made based on the three analyses. In most cases it is not necessary to resort to the reserve sample, a fact which demonstrates the accuracy of the chemist's work.

When the ore arrives at the smelter, it is sampled and assayed by the plant chemist. The various grades of ore are blended and started through the first stage of the reduction. This, a roasting process, results in a chemical change in the ore. The ore, zinc sulfide (ZnS), is heated in the presence of air. Under the influence of this heat, the zinc blende is broken up, the zinc combining with oxygen to form zinc oxide (ZnO), while the sulfur is oxidized to sulfur dioxide (SO_2).

Some plants waste the sulfur dioxide gas while others utilize it in manufacturing sulfuric acid. If the plant manufactures acid from the gas by the

chamber process, the gas is led through a system of settling chambers, where any solids present are deposited. The gas then passes up through a large Glover tower which is filled with perforated, acid-resisting tile. The gas is pulled from the Glover tower by a lead fan and forced into a system of chambers and flues, where, under the catalytic action of nitrogen peroxide, it combines with oxygen and water to form sulfuric acid ($2SO_2 + O_2 + 2H_2O = 2H_2SO_4$). The oxygen comes from an excess of air introduced in the roasting and the water is introduced into the chambers as steam or in a fine spray. As an excess of water is used, the sulfuric acid that is formed collects in the bottom of the chambers as a dilute acid.

This dilute acid is pumped up to the top of the Gay-Lussac towers, from where it trickles down over the hollow packing tile which fills the towers. As the dilute acid descends, it comes into intimate contact with the ascending spent gases from the chambers, dissolving the nitrogen peroxide present. The dilute acid, with the nitrogen peroxide dissolved in it, is then pumped to the top of the Glover tower, from where it trickles down, meeting the hot incoming and ascending sulfur dioxide gas. Under the influence of the heat of the sulfur dioxide, the dilute acid gives up the nitrogen peroxide, which goes back into the chambers with the sulfur dioxide. The heat also concentrates the acid by driving off some of the water as steam, which also passes into the chambers. When the acid leaves the Glover tower, it is of the usual commercial strength, 60° Baumé.

In order to obtain the catalyst, nitrogen peroxide, which is introduced into the system through the Glover tower, nitric acid is needed. This acid is manufactured in a separate unit from sodium nitrate and sulfuric acid ($NaNO_3 + H_2SO_4 = HNO_3 + NaHSO_4$).

In these acid plants, as in the other parts of the plant, the chemist is constantly needed to take samples and analyze them, and to work with the engineers to obtain the greatest efficiency possible. By modern methods, one ton of sulfuric acid is made from one ton of sixty per cent zinc sulfide.

The other product of the roasting process, zinc oxide, is mixed with dead coal (carbon) and charged into the furnaces, which may number from two to a dozen or more.

The furnace is a huge affair with several hundred retorts so arranged that a reducing fire entirely envelops them. The retort is cylindrical. It is about fifty-four inches long, seven to ten inches inside diameter, and has one end closed. The open end rests upon a shelf and faces the workman who fills it with the charge, or mixture of ore and coal. The large end of a hollow frustrum of a cone, the condenser, is then placed in the mouth of the retort and the joint sealed. The small end of the condenser is also sealed except for a small vent hole.

The heat of the furnace gradually raises the temperature of the charge.

Under the influence of this heat, the zinc oxide gives up its oxygen, which combines with the carbon to form carbon monoxide. This gas escapes through the vent, where it burns to form carbon dioxide, which escapes to the atmosphere. When the zinc and oxygen separate, the zinc is volatilized. This zinc vapor, heavy and sluggish, finds its way into the comparatively cool condenser. Here it reaches its dew point and collects on the wall of the condenser in small globules, which grow and finally run down the sides to form a pool of liquid zinc in the bottom of the condenser. The zinc accumulates until it is tapped off into a ladle from which it is poured into molds, where it solidifies. The molded zinc is in the form of slabs or plates weighing about sixty pounds, and in this shape is sold to the trade.

As the molten zinc is being molded, a sample is taken which is assayed for zinc, lead, iron, and cadmium. A certificate of this assay goes to the purchaser, who is guided by it in his use of the metal.

Besides doing the work already mentioned, the laboratory is called upon to make many other analyses and determinations.

When the metallurgical coal arrives at the smelter, it is assayed for fixed carbon, volatile matter, sulfur, and ash. The results of these determinations enables the superintendent to figure the proper amount of coal to mix with the roasted ore in order to prepare the charge correctly. The retorts and condensers are made of fire clay, all of which is assayed for silica, alumina, and iron. Coal for use in the boiler plant and the gas producers is usually tested for its heat value, sulfur, and ash. Many samples from potential ore supplies also find their way to the laboratory for study.

As the charge is being prepared for each furnace, samples are taken of the ore. These are run for zinc, lead, and sulfur. By knowing the percentage of zinc in the ore and the weight charged, the amount of metal going into the furnace can be calculated. The molded zinc is weighed from each furnace and by comparing this weight with the metal contents of the charge, the percentage of recovery is obtained. Good practice averages about ninety per cent. The metal obtained by this process is not so pure as that made by the electrolytic process, and consequently is worth less on the market.

The residue is assayed to determine what percentage of zinc remains after the distillation. Some plants rework these residues in a different type of furnace, producing white zinc oxide and a final clinker which are assayed, the zinc oxide to determine its purity, and the clinker to discover what percentage of zinc is lost. In some smelters, where western ores are treated, gold and silver remain in the residues after the zinc is removed. In such cases the residue is assayed to determine the gold and silver values, and it is then shipped to other smelters that make a practice of recovering the precious metals.

Thus we see that the laboratory in a retort zinc smelter is a veritable beehive of activity. Many chemists are working and quantities of various chemicals are used. A continual check is kept on all operations going on in the plant. The engineers never install new processes without first consulting their indispensable co-workers, the chemists.

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New Caustic Soda Factory for Norway. The Saugbruksforeningen, Holden, one of the largest Norwegian producers of pulp and paper and the largest consumer of alkalies, is building a new electrolytic bleaching plant and will produce caustic soda as a by-product as part of its expansion program. This industry is constantly growing, so that its alkali requirements expand steadily. Therefore, while it is anticipated that the excess alkali from the above plant will be sufficient to satisfy the remainder of the domestic requirements, this cannot be assured, and it seems likely that the necessity for importing considerable amounts will continue. The 1927 imports of caustic soda amounted to 2030 metric tons. This increased about 400 metric tons in 1928.—*Chem. Age*, **20**, 542 (June 8, 1929).

United States Helium Production. New Government Plant Commences Operations. Shipments of helium from the United States Government's new helium production plant, near Amarillo, Texas, began on May 6th. The new plant was built and is operated by the U. S. Bureau of Mines at Soncy, on the Rock Island Railroad, about seven miles west of Amarillo. The helium is extracted from natural gas having a helium content of $1^3/_4$ per cent, produced from the Cliffside structure lying northwest of Amarillo. Gas from 26,000 acres of land is available to the plant through a contract between the Department of Commerce and the Amarillo Oil Co.

The helium-bearing natural gas is transported from the wells to the plant, by the natural pressure of the wells, through a welded steel pipe line eleven miles long. In the plant the gas is cooled to a temperature at which all the constituents except helium are reduced to liquids. The helium is drawn off as a gas, and the liquids are restored to the gaseous state by allowing their temperature to rise to that of the atmosphere. A part of the gas resulting from the evaporation of the liquid is used as fuel to generate power to operate the plant, and the remainder is discharged into a pipe line which carries it to Amarillo, where it is used as domestic and industrial fuel. The process of extracting helium is a continuous one, involving pressures as high as 2500 lb. per sq. in.

The car in which the first shipment was made is one of two specially built helium tank cars owned by the Air Corps, U. S. Army. It carried helium under a pressure of 2000 lb. per sq. in. When the car reaches Langley Field the helium will be discharged into other containers for use in the army's lighter-than-air craft, and the tank car will be returned to the Amarillo plant for reloading.—*Chem. Age*, **20**, 578 (June 15, 1929).

CHARLES MAYER WETHERILL, 1825–1871. PART III*

EDGAR FAHS SMITH

CHAPTER III

Chemical Experiences in Exposition Work and in Travel

Early in 1853 Wetherill closed his analytical laboratory temporarily, in order to accept an appointment by his uncle, John Price Wetherill, as acting mineralogist and chemist to collect samples of Pennsylvania minerals and chemical products for the Exhibition of the Industry of all Nations at Crystal Palace in New York. As this was the first international exposition to be held in the United States there was a wide general effort to make the undertaking a success and Wetherill entered upon his new activities with characteristic industry and enthusiasm. His duties comprised not only the collecting, shipping, and exhibiting of the various minerals, ores, etc., of Pennsylvania but also the preparation of descriptions indicating the scientific, industrial, and economic importance of the various materials which he assembled. This employment, for which he received three dollars a day and expenses, kept him engaged at various intervals for nearly a year. The following type of circular letter which was sent out by Wetherill is an interesting illustration of the first participation of American chemists in exposition work.

Philadelphia, May, 1853.

Dear Sir:

I have been commissioned by the Crystal Palace Association, for the purpose of collecting specimens of the minerals, ores and metals of Pennsylvania, which have an industrial value, and I would request your coöperation in this work, that our department in the approaching Fair may be found worthy of our State.

It is especially desirable that our Iron interest should be well represented; and it is proposed, by the aid of the collections assembled, and by the assistance of experimental investigation by well-qualified Committees to be appointed for the purpose, to elicit such information as shall be useful for the manufacture of this the most important of our State products.

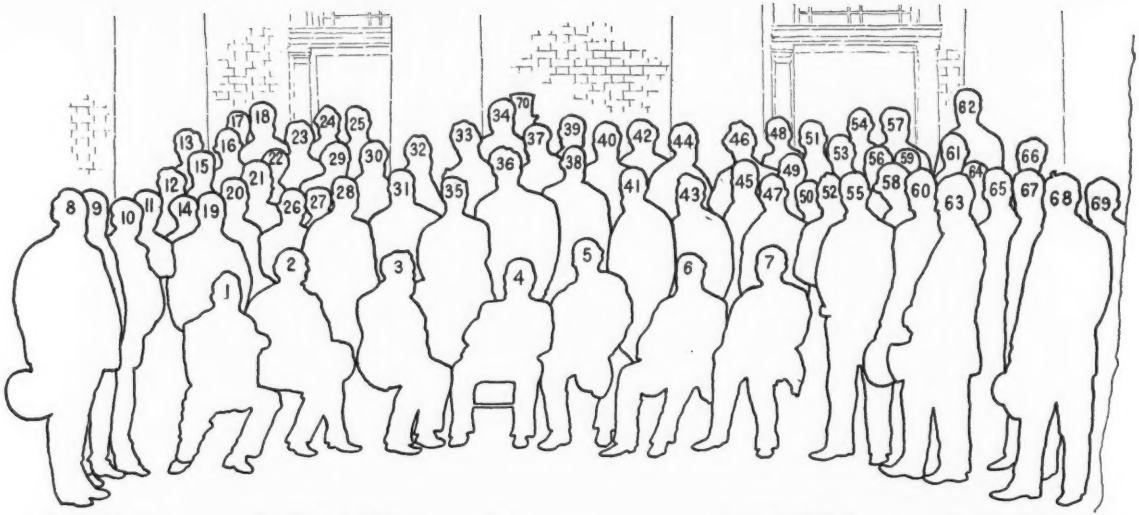
You are requested, therefore, if you feel an interest in this undertaking, to forward, before the 15th of June, duplicate specimens to the address of DR. CHARLES M. WETHERILL, care of WILLIAM HAMILTON, ESQ., ACTUARY OF THE FRANKLIN INSTITUTE, PHILADELPHIA.

It is desirable to have specimens:

1. Of the different ores you use.
2. Of the fluxes.
3. Of the fuel (except in case of charcoal).
4. Of the cinder or slag, and especially of those which are extraordinary, with explanatory labels.
5. Specimens of the different quality of metal produced.

You are requested to send TWO specimens (to be marked No. 1 and No. 2) of each kind of the above mentioned materials, and to be very particular and explicit in the labels, upon which must be designated the name, locality, and quality of the ores;

* This is the last manuscript from the pen of the late Edgar Fahs Smith.



1—B. S. Hedrick
2—E. N. Horsford
3—T. S. Hunt
4—J. L. Smith
5—B. Silliman
6—H. Coppée
7—Rev. T. R. Pynchon
8—Thos. Lyon
9—Conyers Button
10—
11—
12—W. M. Iles
13—
14—E. J. Hallock
15—W. H. S. Thorburn
16—John A. Church
17—
18—S. St. John
19—H. C. Bolton
20—C. F. Chandler
21—E. Waller
22—Arthur Macy
23—H. G. Torrey
24—E. L. Youmans
25—W. K. Kedzie
26—C. A. Joy
27—M. J. Thompson
28—S. P. Sharples
29—
30—
31—J. Priestley
32—S. H. Douglass
33—J. M. Maisch
34—R. C. Kedzie
35—M. B. Priestley
36—David Taggart
37—F. Hoffmann
38—E. T. Cox
39—C. G. Wheeler
40—
41—
42—
43—P. W. Bedford
44—W. W. Daniels
45—H. B. Nason
46—A. P. S. Stewart
47—T. G. Wormley
48—F. W. Clarke
49—A. A. Breneman
50—C. S. Allen
51—
52—
53—H. Endemann
54—
55—P. Frazer, Jr.
56—A. H. Gallatin
57—C. H. Chandler
58—Traill Green
59—
60—W. H. Chandler
61—
62—J. P. Remington
63—
64—E. W. Hilgard
65—A. R. Leeds
66—
67—T. M. Drowne
68—P. H. Vander-Weyde
69—
70—

Jubilee Number, J. A. C. S.

A GROUP OF AMERICAN CHEMISTS, 1874

This first photograph of a group of American chemists was taken by L. H. Laudy of Columbia College School of Mines on the occasion of the Joseph Priestley Centennial of Chemistry, Northumberland, Pa., August 1, 1874. Coppée, Sharples, Silliman, Jr., Hosford, and many other prominent chemists with whom Wetherill was associated attended this celebration. Doubtless, had he lived, Wetherill himself would have been included in this group.

the kind and quality of metal produced; the kind and locality of the flux and of the fuel; and whatever else you may deem interesting to be communicated.

With regard to the size of specimens, it is desirable to confine yourself to four by five inches, or to multiples of this size. The iron should be a pig broken across (with a clean fracture), and in a section of three inches.

The specimens to be sent by Forges and Rolling Mills are also very important. The sizes must be the same as those already mentioned; for example, for railroad bars, a section of three inches in length. Two specimens of each, to be sent to my address, with labels stating the kind of iron used, its Furnace, and such information that you may think proper to submit.

All other minerals and building materials, and economical minerals (the size of which must be cubes of 4 x 4 x 4 or 5 x 5 x 5 inches), will be thankfully received.

We would also be thankful for the LOAN of such fine specimens from private collections that the owners may be desirous of retaining. Such had better be sent direct to the address of Prof. B. Silliman, Jr., Office of the Association for the Exhibition of the Industry of all Nations, No. 53 Broadway, New York. They must be reclaimed at the close of the Exhibition, when they will be carefully re-packed and held subject to the order of the owner.

Hoping that you will coöperate in an undertaking of such interest to Pennsylvania, I remain

Yours truly,
Charles M. Wetherill

In connection with his work for the Crystal Palace Fair Wetherill prepared extensive reports upon the iron, coal, and other mineral resources of Pennsylvania which were published in the annotated Catalog of the New York Crystal Palace Exposition in 1854. The account of blast furnace operations in different parts of Pennsylvania is invaluable to the historian of the American iron industry. Many of the analyses of ores and minerals, contained in this report, were made by Wetherill himself.

Wetherill's excursions to different parts of Pennsylvania in order to gather specimens for the Crystal Palace Exposition brought him in close contact with the natural resources of his state and when the great fair was over he had formed the natural resolution of making a similar exploration of the mineral resources of the Northwest. This plan materialized the following year when he left Philadelphia in midsummer with the following general letter of introduction:

Philadelphia, July 20th, 1855.

We the undersigned understanding that Dr. Charles M. Wetherill of Philadelphia (a practical chemist, Member of the American Philosophical Society, of the Academy of Natural Sciences of Philadelphia, and of the Franklin Institute of the State of Pennsylvania) is about to travel through these United States for his further improvement, do hereby cheerfully recommend him to the kind notice, not only of our personal friends but also lovers of Science generally.

Robert Bridges, Prof. Chemistry, Phil. Coll. Pharm.; V. Pres., Acad. Nat. Sciences

Joseph Leidy, Prof. Anat. Univ. Penna. and Curator Acad. Nat. Sciences
Wm. S. Zantzinger, Librarian, Acad. Nat. Sciences
John Cassin, Curator, Acad. Nat. Sci., Phila.

After proceeding by railroad to Cleveland, Wetherill took passage on August 15th, on the lake steamer "Plant" of 1200 tons in order to visit the mineral deposits of the Lake Superior region. On the voyage to Superior stops were made at Detroit, where Wetherill visited the infant chemical industries of that thriving city, and at Marquette, where he inspected the immense iron deposits of this locality. On the return voyage from Superior Wetherill visited the extensive copper works on the southern shore of Lake Superior at Ontanagon, Eagle Port, Eagle Harbor, and Copper Harbor. From Detroit he made an overland excursion to Chicago, Milwaukee, and Madison, continuing thence to the lead districts of Wisconsin, Illinois, and Iowa with stops at Galena, Dubuque, and other centers. Wetherill next made an excursion into Minnesota and Dakota where he spent six months visiting the Chippewas, Winnebagos, Sioux, and other Indian tribes. He published a very full account of his trip to the Northwest in the *Jahrbuch der k. k. geologischen Reichsanstalt* of Austria[15] under the title "*Wahrnehmungen beieiner Bereisung des Kupfer- und Blei-Gebietes im nordwestlichen Theile der Vereinigten Staaten Nord -Amerika's.*" The report is a most valuable and interesting document, of which unfortunately no English rendering has been published.

Wetherill at this time was thirty years of age and his main ambition now was to acquire a permanent position of good standing in which he could make the best use of his extensive and varied chemical training of the past ten years. A position as Professor of Analytical Chemistry at the Wagner Free Institute of Science in Philadelphia, which had been offered to him on July 31, 1855, was declined in view of the plans for his journey to the Northwest.

Few American chemists of the middle-nineteenth century period had so large a number of influential scientific friends as had Wetherill. A. D. Bache, Joseph Henry, Wolcott Gibbs, R. Odgen Doremus, J. F. Frazer, J. L. Smith, E. N. Horsford, Benjamin Silliman, Jr., A. A. Hayes, and many others can be named as among his friends and correspondents, all of whom were anxious to assist him in finding a desirable professional position. The most devoted of these friends was Wetherill's college professor, Alexander Dallas Bache, an eminent scientist and most charming gentleman, who took a loving fatherly interest in the welfare of the young chemist. This is shown in the following series of letters that were written in 1856 in an effort to induce Wetherill to accept the Professorship of Chemistry at the College of Physicians and Surgeons in New York. They are most human

[15] **7**, 4th quarter, 771, 1856.

documents which give us some interesting glimpses of the chemists and chemistry of America of seventy years ago.

Washington, June 7, 1856.

Dear Doct.

Professor Gibbs writes to me "About Wetherill. I do not care for the place myself and will do my best for him if he would like it. I think his chances would be good and I shall have some influence in the matter. The place is now vacant and they are urgent with me to accept it but I cannot give 3 lectures a day (He refers to this and the two in the Free Academy). I should have no time nor strength for investigation. Let Wetherill come on and show himself."

What shall I do further? Will you go to N. Y. as Prof. G. suggests? It might be worth while even if nothing comes of this present matter. I was told that the place yielded about say $1000 for the course.

Let me hear at once.

Yours truly,
A. D. Bache

Washington, June 18, 1856.

Dear Doctor:

The chair in New York Coll. Phys. & Surgeons is yet vacant and the gentlemen there would be very glad to see you. I have had two letters from Doctor Chandler R. Gilman, Prof. of Obstetrics, who seems very much interested in the matter and tried to reach you by letter to the Virginia Springs. I would advise you to see the gentleman and confer as early as you can. Dr. Gilman's residence is N. 5 E. 13th St., N. Y.

I send a copy of this to the address of your mother to be forwarded but this may not find you as early as it is desirable.

Of course any aid I can render is given. Prof. Frazer was written to from N. Y. & has given a strong letter as I understand.

Yours truly,
A. D. Bache

New York, July 1, 1856.

Dr. Charles M. Wetherill,

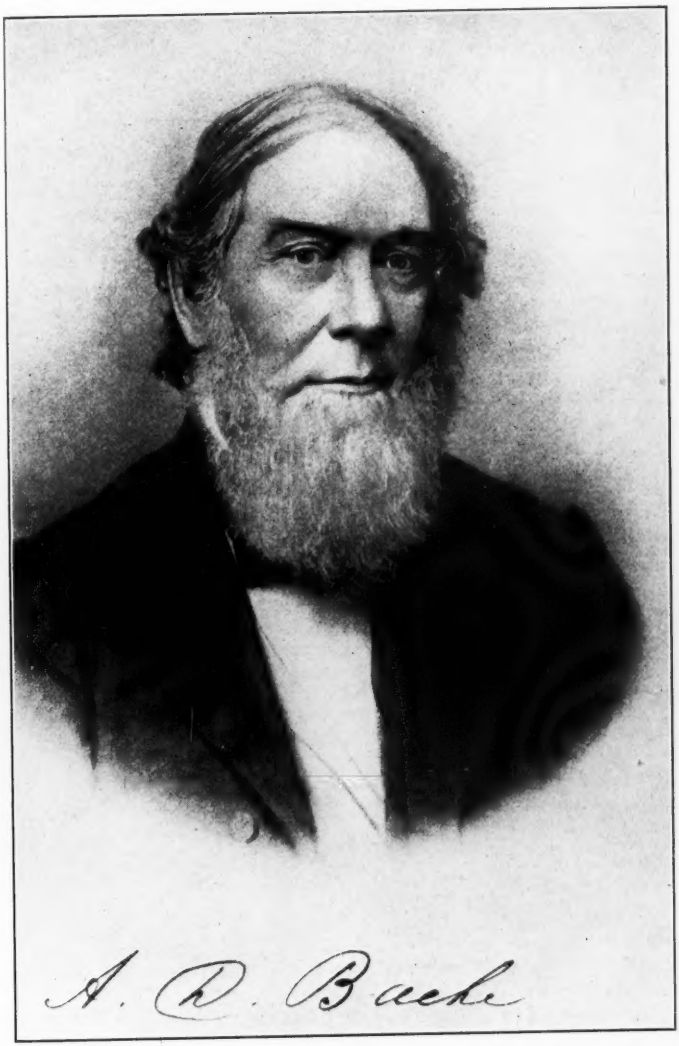
Dear Sir,

I learn from our mutual friend Dr. A. D. Bache that he has written to you in reference to the Chair of Chemistry now vacant in the College of Physicians and Surgeons of our City. As the time when this Chair must be filled is very near, I am very anxious to hear from, if it be not possible that we should see, you.

There are other parties who will be pressed as Candidates and if you desire the place it is essential that we hear from, or see, you without delay. From what I have heard from Bache I feel strongly disposed to adopt you as my individual preference. But of course we can do nothing till we are advised whether you desire the place or no—if you do, your chance would be very much increased by a visit to New York that those who know you as a scientific writer may have the opportunity to pay their personal respects to you—Pray let me hear from you at your earliest convenience and if compatible with other engagements let us see you soon.

Please address *or call on*
Dr. C. R. Gilman,
No. 5 East 13th Street,
New York.

Very respectfully,
C. R. Gilman



ALEXANDER DALLAS BACHE (1806–1867), SUPERINTENDENT OF THE U. S. COAST SURVEY 1844–1867

Washington, July 8, 1856.

My Dear Doct.

I have just returned to Washington from a professional visit to New York and am much gratified by the receipt of your note of the 28th and letter of the 29th June. I shall not fail to persevere as far as any influence of mine can go until you are safely landed on those shores to which you refer. While in New York I saw Dr. Gilman several times. He is very earnest that you should visit that city and see his colleagues and if you can possibly do so, I think it very advisable that you should, if merely for a visit of limited duration. On his last visit he told me there were "other Richmonds in the field" and that he was very anxious to keep them in abeyance until you could come on when he thought the matter would be readily settled. Can you not make them a visit at once? Communication is so ready now that a few days will carry you right into their midst. I sympathize fully with you in the disappointments which you express and only wish that I had been in Philadelphia to endeavor to give a different turn to it, more in accordance with your merits and aspirations. Life is strangely made up and no one, more than myself, knows the value of good friends, ready to act when opportunity offers. May you in your new connection find all the stability wanting in the first. I know something of the shock to which you refer and of the better results of a second choice. I want to see you in that position in New York if you find it a suitable one. It will give you prominence and I hope you may make it tell for science in our country as well as for your private advantage. Let me know your intentions. With best regards

Yours truly,
A. D. Bache

New York, July 2/56.

Dr. Charles M. Wetherill

Dear Sir:

Yours of 29th is just at hand. I had the honor to address you yesterday to Care of Mrs. W. in Phila.

Referring to that I will answer your Queries in their order.

1st. As to salary &c.—The Chair is supported by fees—$15 from each student. The aggregate has in times past varied from 1000 to 2000 or perhaps 2500. I think for next year it may be a fair calculation to say one thousand dollars free of Lab. Ex. This however may be more or less.

2nd. As to apparatus &c.—The College possesses no apparatus of any kind.

3rd. The course begins about the middle of October and ends the 2nd week in March. Three or four lectures a week have usually been given.

4th. As to the expenses of living (moderately) it is difficult to speak. The word moderately means such different things—I will give the best data I can—If you board it will cost $15 per week at least in a private boarding house—At the larger houses it would vary from 25 to 75 per week always for two people.

At housekeeping—Rent from 700 to any sum you choose to name—Servants wages $6 to $7—fuel & gas rather more than in Philad. say from 150 to 200—Groceries & marketing rather dearer than in Philad.—As to the aggregate of all these and the thousand other items that run away with money I can only give my opinion I should think that a man & wife could keep house in New York for $2000 per annum. but it would require strict economy. An addition of $500 would be easily spent—At board two persons can I think live for $1500. There is one other item as to the College. We have put up a new building costing some $80,000 of this we paid about $10,000—

leaving a mortgage of $70,000. Of this each professor is expected to take $3000. On which he will receive interest if the funds hold out, if not—not. This $3000 is then a perfectly safe investment but it *may not* pay full interest for a year or two—The building brings us a Rent (from Stores in the basement) of $3000. We expect to receive from the rent of other rooms, say $800—This pays the Int. on rather more than 50,000—if our expectations are realized you will get interest the second year without any doubt. Please consider all these College matters as Confidential. We of course keep such things in the family, but of course I wish you to know the ground *perfectly*.

As to the time of election, no day is yet fixed, chiefly because the Faculty have not yet agreed on a Candidate but we cannot put it off much longer. If on giving the subject full consideration you resolve not to be a Candidate please write me to that effect or what would greatly oblige me, send by Telegraph "I have received your letter and answer No—" If you determine to be a Candidate write at once, but come on as soon as possible. There are several names before us and as I said before the choice cannot be put off much longer.

Very truly yours,
C. R. Gilman

P.S. This being a semi official letter I trouble you with another for which I alone am responsible.

Private.

As I do not hesitate to say I wish to have Dr. Wetherill for a Colleague, I hope he will pardon me for troubling him with some points on the subject to which he will attach what value they seem to deserve but for which the College is in no shape responsible.

I think that if a young man of the right sort would take our Chair of Chemistry and throw himself into it with energy he could not fail to build up a great reputation and, if he desired so to do could add very materially to his income. I know that Torrey by doing what he called "jobs" analysis & the like made several hundred per Ann. and Dr. Ellet has done more in that way. Again it is my conviction that much might be done by the Prof. with private teaching. There are in every class some students who want to do work in the Lab. These will pay—

There is room for this and I think an opening—Draper does little or nothing in the way of original research. Gibbs is engaged six or seven hours every day in teaching little boys in the Free Academy—Torrey is out of Chemistry altogether. Ellet is lazy and only does job work for the Gas Companies and if you know Dr. Doremus you are aware that he is emphatically *"Vox et praeterea nihil."* He can lecture about Chemistry but is not a Scientific Chemist. I mention all these things to prove that there is an opening for a Scientific man who will devote all his energies to Chemistry in New York—I hope Dr. Wetherill will pardon the freedom with which I write.—

Very truly,
C. R. Gilman

Washington, July 12, 1856

Dear Doct.

Yours of July 6 inst. reached me yesterday. I regret that you have been obliged to come to the conclusion which you communicate, but really can see few charms in the position offered, hampered as it is with such pecuniary outlay. The game might or might not be worth the candle. I shall not fail to keep my eyes open to see any position which may be suitable to you. If you were a poor man, you would have to

work and science would be the gainer. In the last generation we lost Henry Seybert just in the same way and I suppose his laboratory remains like the palace of the King of the Marble Isles to this day. In a different way we lost William H. Keating, but none the less lost him to science. So it goes in our country and between the men of fifty and those of thirty very few are embarking on a scientific career. Let me hear from you from time to time.

Yours truly,
A. D. Bache

Doct. C. M. Wetherill.

Smithsonian Institution
July 19, 1856.

My dear Sir:

Previous to the receipt of your letter of the 6th inst. Prof. Bache had spoken to me in regard to you and I had promised to back his recommendation of you for any position in the chemical line which might offer.

I regret to learn the state of your feelings and prospects in regard to science and I ought before now to have given you a word of comfort; your letter, however, was received just after my return from a short tour to the West and amidst a press of business which could not be postponed.

I think you look too strongly on the dark side of the picture. You have not lived in vain. You have added new truths to the existing stock of knowledge and I doubt not will add many more of still greater importance. I think you would be untrue to yourself and your fellow men if you abandon science after having spent so much time and money in preparing yourself for its successful cultivation.

Though you have not yet obtained a position such as you could desire you have done more, you have deserved one.

I shall not fail if I hear of a vacant situation to confer with Mr. Bache relative to it in regard to yourself. If you should not soon succeed in procuring a position cannot you turn your attention to the improvement of some process of art? I know that when we woo science for pecuniary ends she is frequently coy and unpropitious; but perseverance in a given course as a general rule will ultimately be crowned with success. I know you may say that these truisms do little toward advancing your cause, but in answer I may remark that the repetition, at a proper time, of maxims of this kind may serve to confirm a wavering purpose and to induce new action. I do not relish the idea of your giving up chemistry. There is certainly a growing demand for practical chemistry in this country and I cannot but think that if you continue to extend your reputation by original papers you will ultimately command a position of profit if not of great honor.

I remain very truly,

Your friend and serv't
Joseph Henry

C. M. Wetherill, Esq.
Philadelphia.

P.S. Cannot you give us a memoir for the transaction of the Institution? We could make a small allowance to pay actual expenses.

Wetherill's part in this interesting correspondence is not preserved or we might know more of the reasons which caused him to decline the New York position. The rather meager inducements, as pictured by Dr.

Gilman, when coupled with a compulsory financial obligation of rather uncertain character, were not likely to prove very attractive—especially at a time when Wetherill was suffering from a transient state of melancholia, induced by some bitter experience of a personal nature, in which he lost all interest in life and despaired of accomplishing anything further in chemistry.

Wetherill was fortunate in this emergency to have two such friends as Alexander Bache and Joseph Henry, whose kindly advice no doubt did much towards reviving the disappointed hopes of the unhappy young chemist. But there was another person, whose sympathy at this time was of far greater influence than the friendship of these two distinguished scientists, and this was Miss Mary C. Benbridge of Lafayette, Indiana, whom he had met the previous year upon his return through Chicago from the journey to the Northwest. She was the daughter of Thomas Truxton and Ann Coleman Benbridge and the great-grand-daughter of Commodore Thomas Truxton of Revolutionary fame, whose eldest daughter married Henry Benbridge, a well-known artist of Philadelphia. The pleasant sequel of this chance acquaintance was the marriage in November, 1857, of Miss Benbridge and Wetherill, who immediately transferred his residence from Philadelphia to his wife's home at Lafayette, Indiana.

Chapter IV

Chemical Activities at Lafayette, Indiana

During the next five years, which were spent at Lafayette, Wetherill gave his attention almost entirely to local matters. At the time of his marriage the city of Lafayette was engaged in boring an artesian well and on February 18, 1858, a vein of running water was struck at a depth of 216 feet. The well was then injured by further injudicious boring and the flow of water having stopped the charge of matters was taken from the contractor and entrusted to Capt. T. H. Rogers and Dr. Wetherill. The leak was finally stopped by an ingenious device of Wetherill's own invention and the flow of water was again resumed. A description of the well and a complete chemical analysis of the water, which was of the sulfur type, were published by Wetherill in the *American Journal of Science* for March, 1859 (p. 241). Another report "On the Chemical Analysis of the White Sulfur Water of the Artesian Well of Lafayette, Ind.," of which Wetherill was the author, was published by the Mayor and Council of Lafayette, at the request of a committee of citizens.

In conducting his analytical work upon the artesian well water of Lafayette, Wetherill was greatly hampered by a lack of laboratory facilities. He was without apparatus except such as could be secured in Dr. Lawrence's small drug store, where he boiled down many gallons of water

in a specially constructed reservoir upon a stove in order to obtain a residue of salts sufficiently large for the analytical determinations, in which he made use of the ordinary druggist's scales. The accuracy of Wetherill's determinations of the different ingredients in the water, as performed under such disadvantages, is quite remarkable, subsequent analyses of the same water at Purdue University with modern apparatus having shown but a slight difference in the findings.

Another piece of public service which Wetherill performed for his community was his "Investigation on the Cost of Illumination in Lafayette," which was published in the *American Gas-Light Journal*.[16] His investigation, which showed that 70 cents worth of coal oil produced the same amount of light as a dollar's worth of Lafayette gas, led to an improvement in the quality of the city's gas.

Some experiments upon the modification of cows' milk for infant feeding, suggested perhaps by the nutritive needs of his own children, were published by Wetherill under the title "Artificial Lactation" in the *Transactions of the Indiana State Medical Society* for the meeting held at Indianapolis on May 17 and 18, 1860. This paper, with its suggestion for improving the nutritive properties of cows' milk for infant feeding by the addition of milk sugar and a small quantity of alkaline phosphates and sodium chloride, is a pioneer contribution to a nutritional subject of the greatest importance, and it shows how Wetherill in this case as in various other instances was considerably in advance of his time.

During the period of his Lafayette residence Wetherill was a frequent contributor to newspapers upon topics of chemical interest and in this way performed additional services that were of value to the community. In the *Lafayette Daily Courier* for April 13, 1859, he reported the detection of arsenite of copper in a sample of colored candy which had caused the illness of several children and called attention to the danger of the use of poisonous colors in the manufacture of confections. He contributed also articles upon agricultural chemistry, fire prevention, ozone, and numerous other topics to the papers of Lafayette and other cities.

Another most valuable chemical service which Wetherill performed during his residence at Lafayette was the writing of his well-known treatise "The Manufacture of Vinegar; Its Theory and Practice, with Especial Reference to the Quick Process." The work was sent to the publisher on June 1, 1860, with a dedication to his friend Dr. R. Ogden Doremus, Professor of Chemistry at the New York Medical College. Wetherill states in his preface that "this book was written to fill a void in the literature of its subject" and he had "felt the need of such a work in the course of his profession as an analytical and consulting chemist." The latter statement is interesting for it indicates that notwithstanding his continued

[16] Vol. I, 230–46 (1860).

aspirations for a college professorship he designated himself as a worker in the field of practical and applied chemistry. Wetherill's treatise on "The Manufacture of Vinegar" was the result of an original plan to translate Otto's "*Lehrbuch der Essig Fabrikation*," but while making full acknowledgment of his indebtedness to Otto and other writers he added "I desire also to assume for myself some information arising from an acquaintance with a practical experience of the manufacture of vinegar."

The discussions of the theories of fermentation contained in Wetherill's book give the chemist of the present day an excellent idea of the general state of knowledge upon this subject as it existed seventy years ago. The ideas presented represent the general conception of Wetherill's teacher Liebig which had not yet been combated by the discoveries of Pasteur.

> Vinegar (writes Wetherill) is the best ferment.....During the process of manufacture and also when the product is stored, a swollen slippery substance is generated. It is a plant (*Mycoderma aceti*) and is called popularly "mother of vinegar," because it acts as a powerful vinegar ferment, which property is due, doubtless, to the immense amount of vinegar with which it is saturated.....Schulze observes with respect to the vinegar *ferment*, that it brings about the decomposition of the alcohol; while the *acetic acid* determines that said decomposition shall be into acetic acid and water, and not into other products. Of what this ferment exactly consists we are yet ignorant; but that it is generated from certain nitrogenized products present in the vinegar is very probable. Some, indeed, deny the idea of a *ferment*, properly so called, and point to the acetification of alcohol by platinum, for their reason. If this be a correct view, what the others call a *ferment*, the latter characterize as a *catalytic agent* (pp. 210, 212, 267).

In the light of present knowledge Wetherill's treatise on "The Manufacture of Vinegar" is much stronger upon the practical than upon the theoretical side. It was written primarily for the purpose of giving information upon the "quick vinegar process" although the old slow process of cask fermentation is fully described. Persons engaged in the manufacture of vinegar welcomed the volume and depended very largely upon it in their practical work. It was the outgrowth of much experience on Wetherill's part and remained for years the standard book upon the subject.

Chemists of today will perhaps be interested to know the terms of the contracts to which their predecessors of seventy years ago subscribed in the publication of chemical books. The following letters of Lindsay and Blakiston with regard to the publication of Wetherill's "Manufacture of Vinegar" are very informative upon this subject:

> No. 20 South Sixth St., North of Chestnut Street.
> Philadelphia, Mch. 29, 1860.
>
> Mr. Charles M. Wetherill,
> Lafayette, Ind.
>
> Dear Sir:
>
> Your letter of the 1st inst. came duly to hand. After, as you may suppose, a long consideration we have concluded to accept yr. proposition to make 1000 copies of yr.

work on vinegar for which we are to pay you *no* copyright. Should a second or any future editions be required we are to pay you ten per cent upon the retail price for each and every copy sold, accounts rendered and payments to be made on the 1st Aug. and 1st Feb. of each year. We have concluded not to stenotype the work but to set up and distribute the type after the 1000 copies are printed. Should another edition be required you will probably have some additions or corrections to make to it. It is probably better that scientific books be not stenotyped at first for it is very apt to be the case that fresh and sometimes very important facts are brought to the attention of the author after his book is before the public. We have put the mss. into the hands of the printer and the wood cuts into the engravers hands and hope shortly to send you proofs when we will write you in reference to them as it will be necessary for you to read them as they pass through the press.

Respectfully yrs.
Lindsay and Blakiston.

The thousand copies of the first edition of Wetherill's treatise on vinegar were not all sold until 1868, when the following letter was written concerning the publication of a second edition.

Philadelphia, April 11, 1868.

Dr. Charles M. Wetherill,

Dear Sir:

We regret that we had not the pleasure of a personal interview with you during your late visit to our city but from the reading of your letter of the 9th inst. just at hand infer that you are willing to revise and bring up a second edition of your work on vinegar for the sum of one hundred and fifty dollars *cash* to be paid on the completion of the reading of the proofs. If we are right in our conclusion please inform us by return of mail how soon you will have the revised copy ready for the press and we will make arrangements to have the work printed at an early day.

Very truly yours,
Lindsay and Blakiston.

Apparently no second edition of the vinegar treatise was ever published. It appears from the correspondence that the writing and revision of chemical treatises in Wetherill's time offered very little attraction to authors in the way of pecuniary rewards.

Shortly after the publication of his book upon vinegar Wetherill determined to leave Lafayette and to try his fortunes once more in the East. He addressed letters of inquiry to his old friends Professors Doremus and Bache from whom he received the following replies which contain reflections of the troubled conditions that followed the outbreak of the Civil War.

New York, 70 Univer. Place
August 22d, 1861.

Mon Ami Wetherill:

It is a treat to hear from you. I am glad you are turning your eyes eastward.

I showed your letter to Professor Raphael, who is acting Dean of the "N. Y. Med. College"—the Chair of Chemistry in this Institution is unoccupied.

I have connected myself with a new enterprise, the "Bellevue Hospital Medical College"—which offers to the medical student practical instruction from 2700 beds, in addition to a regular course of lectures. It is the best basis for a Medical College in this country.

I shall take great pleasure in making your wishes known in regard to a Professorship—but chemical chairs with a remunerative salary are scarce articles, East as well as West.

We have all been delighted with your work on the "Manufacture of Vinegar" in which you so highly honored your humble servant—for which allow me to repeat my indebtedness. Apart from the scientific labor bestowed on the work—the style of the book is neat beyond comparison. How does it succeed? You have exposed the theoretical and practical parts of your subject so lucidly, that I should judge it would prove an attractive volume.

Dr. Budd and myself are engaged in experimenting with that great civilizer of the age, *gunpowder;* we are endeavoring to avoid the use of woolen or other envelopes for the powder—employing it in compact masses suited to the calibre of the Cannon, Musket or pistol. We have orders from Govt. to experiment with the gun pendulum at West Point for the army—and with the gun pendulum and ballistic pendulum at the Washington Navy Yard, for the Navy.

How are you off for a family? Mea carissima presented me with a daughter abt. 3 weeks since—of course a most beautiful charming one. We have three boys living—we lost one a year ago. My eldest* is quite chemically inclined.

I have seen Charlie Harris† several times lately. He finds it difficult to make headway against his many trials. I wish I knew of some good situation for him. If you hear of any please let me know.

Yours cordially,
R. Ogden Doremus.

To Dr. C. M. Wetherill,
Lafayette, Ind.

Washington, August 27, 1861.

My dear Sir:

Everything is in such confusion yet in this part of the country, not having adapted itself to the state of war suddenly forced upon it by the rebels, that no one can tell how soon the educational institutions will be able to start. Hence it is a very bad time to make a change of place. It may happen that some such vacancy as you seek may open but you could hardly be sure that it would be at all enduring and might find that after all the expense and trouble you had incurred a loss. The institutions here are curtailing their expenses and the young men of college years are entering the army.

Should I hear of anything such as you describe you shall know it.

Truly yours,
A. D. Bache.

Dr. Charles M. Wetherill

On January 15, 1862, Wetherill read before a meeting of the Indiana State Dental Association a paper upon "The Application of Chemistry[17] to

* The late Dr. Charles Avery Doremus (1851–1925).

† Dr. Charles Townsend Harris with whom Dr. Doremus operated an analytical chemical laboratory in New York in 1848.

[17] **16,** 5 (Jan., 1862).

Dentistry," which was published in *The Dental Register of the West.* The article describes the preparation and properties of the various metals, alloys, amalgams, cements, porcelains, and plastics that are used in dentistry; the chemical constituents of teeth and their alteration by decay; and the chemistry of the preservation of teeth. The paper is a very full presentation of the subject both from the historical and practical standpoints and can still be read with interest by students of dentistry.

It is significant that while the attention of the country was being concentrated at this time upon the prosecution of a bitter domestic war an important national movement was also being sponsored for the establishment of a Federal Department of Agriculture. Surprise is now expressed that the establishment of a department for improving so important and basic an industry as that of agriculture, the principal occupation of the American people, should have been delayed for nearly eighty years after the founding of the Republic. In 1842 the Commissioner of the Patent Office, upon his own initiative, began to publish annual reports upon the agriculture of the country and this policy was continued until 1862 by succeeding Commissioners who in their yearly publications included important articles by J. C. Booth, T. G. Clemson, C. T. Jackson, J. von Liebig, C. Morfit, and other leading chemists, upon the applications of chemistry to agriculture. The Patent Office equipped a laboratory where its own chemists (Dr. Thomas Antisell and others), in the midst of their regular duties, made analyses of soils, fertilizers, grains, and other agricultural products. The demands for this extra service finally reached such a point that Congress was petitioned to establish an independent bureau or department which could relieve the Patent Office of its agricultural work and give full undivided attention to the increasing number of requests for scientific research upon agriculture.

Knowing that the first scientific appointment in the proposed new department was to be that of chemist, the friends of Wetherill immediately presented his name as a candidate for this office. His chief supporter for this appointment was once more his loyal friend Professor Bache of the Coast Survey:

Washington,
May 14, 1862.

My Dear Sir:

The bill for the Agricultural bureau having passed I have at once addressed your friend Senator Wright on the subject in your behalf. I shall decline giving any other recommendations as long as you are in the field. Can I aid you further?

Yours truly,
A. D. Bache.

Dr. C. M. Wetherill.

Some of Wetherill's friends even recommended him for the head of the new department as appears from the following letter:

H. R. Wash. May 21, 1862.

My Dear Sir:

You speak correctly about the multitude of applications; but I have already anticipated your wishes. I promised my colleague Mr. White that I would join him *heartily* in recommending Dr. W. So also will our two Senators, who indeed recommended him, but uselessly as I knew, for Supt. of the Dept.

Gratified that I am able to oblige you also in this I am
in great haste but

Very truly yrs.
Schuyler Colfax.

I. L. Meredith, Esq.

Governor Curtin of Pennsylvania also lent his influence in support of Wetherill's appointment.

Executive Chamber.

Harrisburg, Pa., 30th May, 1862.

Sir:

I unite with the friends of Doctor Charles M. Wetherill, of Philadelphia, in recommending him for the Chemical Department of the Agricultural Bureau recently created by Congress. The Doctor is a finished scholar and gentleman; his education in this country and in Europe eminently qualifies him for the duties of the position and in all respects his appointment would be proper and satisfactory to the people of the State.

Very respectfully,
Your obt. servant,
A. G. Curtin.

A. Lincoln,
President.

Polish Rubber Industry Developing. The rubber industry in Poland has made notable progress since the tariff conflict with Germany began in 1925, which led to the restriction of imports of manufactured rubber goods, according to the Department of Commerce. The contingent system of rubber imports was abolished in March, 1928, but a substantial increase in customs duties which accompanied the removal of restrictions left Polish manufacturers with a high degree of protection.

Prior to 1914 only one rubber-manufacturing establishment existed in Poland, the market being supplied mainly by the large Russian plants of Treugolnik and Prowodnik. During the years 1919 to 1923 five new manufacturing plants were opened in Poland. There are now fifteen plants in operation, employing between 6000 and 7000 workers. The production of rubber goods has increased from 450 tons in 1924 to 1900 tons in 1926 and 3000 tons in 1927, while the importation of crude rubber has increased from 725 tons in 1926 to 1753 tons in 1927 and to 1455 in the first half of 1928. Poland's crude rubber purchases are made through Hamburg, London, and Paris. Notwithstanding the steady increase in domestic production, imports of rubber goods into Poland have not yet begun to show any decline.—*Ind. Eng. Chem.*, **21**, 176 (Feb., 1929).

THE IN-ORGANIC SIDE OF ORGANIC CHEMISTRY[1]

CHARLES A. KRAUS, BROWN UNIVERSITY, PROVIDENCE, RHODE ISLAND

The first synthesis of an organic compound from in-organic constituents was accomplished by Wöhler one hundred years ago. With this synthesis, the distinction between organic and in-organic chemistry was definitely broken down and it might have been expected that subsequently these two fields of chemistry would develop more or less together and that they would exert a marked influence on each other. However, such has not been the case. Up to the present time, chemistry is still rather sharply divided into the organic and the in-organic divisions and there are but few chemists whose interests lie in both fields, or the results of whose investigations are applicable to both.

This state of affairs is, in part, due to the reluctance of chemists to break away from time-honored tradition. But, in a measure, it is also due to the great difference in the behavior of common organic and in-organic compounds. There is a regularity in the behavior of organic compounds that, seemingly, is entirely lacking in the case of in-organic compounds. The conditions under which most reactions of organic chemistry are carried out differ widely from those of in-organic chemistry.

On the whole, the organic chemist has been more enterprising than the in-organic chemist. He has felt free to make use of in-organic materials in carrying out his syntheses of various organic compounds, while, at the same time, he has claimed as his own practically all compounds containing carbon. Now, it is true that any compound containing carbon may properly be termed an organic compound, but it does not necessarily follow that all the reactions of such compounds are properly classed as organic reactions. Indeed, numerous reactions of organic compounds might well be termed in-organic.

An organic compound may contain a considerable number of atoms other than carbon and hydrogen. Many of our most important organic compounds are of this type. I need only mention the organic derivatives of oxygen, nitrogen, sulfur, phosphorus, arsenic, etc. If, in a reaction of a compound containing elements other than carbon or hydrogen, the valence bonds of carbon are not concerned; that is, if only valence bonds of in-organic elements are primarily involved, then such a reaction might well be termed an in-organic reaction of an organic compound. The mechanism of the reaction is primarily determined by the atom of the in-organic element, and carbon, in so far as its presence in the compound has any influence at all, serves merely as a make-weight.

[1] An address delivered before the New England Association of Chemistry Teachers at Brown University, March 16, 1929.

Let me illustrate what I have in mind. A typical in-organic reaction is that between an alkali metal, such as sodium, and water, which takes place according to the following equation:

$$HOH + Na = NaOH + {}^1/_2H_2$$

The reaction consists in that one of the hydrogen atoms of water is substituted by sodium, with the consequent formation of sodium hydroxide and molecular hydrogen. The mechanism of the reaction, of course, involves an electron due to sodium, but for the purposes of our present discussion, we need not go into the details of this mechanism. Now, let us consider the reaction that takes place when ethyl alcohol is treated with sodium. This reaction is expressed by the following equation:

$$C_2H_5OH + Na = C_2H_5ONa + {}^1/_2H_2$$

The reaction is strictly analogous to the preceding one between water and sodium. In both cases a hydrogen atom, attached to oxygen, is replaced by sodium. The only difference lies in that, in the first reaction, the second valence of oxygen is satisfied by hydrogen, while, in the second reaction, the second valence of oxygen is satisfied by an ethyl group. It is to be noted, however, that in the second reaction the ethyl group itself takes no direct part in the reaction; after the reaction, as before, it is attached to one and the same oxygen atom. And, moreover, the properties of sodium alcoholate do not differ materially from those of sodium hydroxide. There is no need here for differentiating between the two reactions and, indeed, to so differentiate would merely serve to obscure the generality of the fundamental reaction that is involved in both cases.

Let me give another illustration. When aniline is treated with sodium under suitable conditions, sodium anilide is formed according to the equation:

$$C_6H_5NH_2 + Na = C_6H_5NHNa + {}^1/_2H_2$$

Aniline is an important organic compound and sodium anilide is an important organic reagent. Nevertheless, this reaction does not differ essentially from the following reaction, which is a purely in-organic one:

$$HNH_2 + Na = NaNH_2 + {}^1/_2H_2$$

The latter reaction represents what occurs when ammonia is treated with sodium under suitable conditions. It is obvious that the two reactions are strictly analogous, that the presence of the phenyl group in aniline does not materially affect the reaction mechanism and that, moreover, the resulting products of the two reactions, sodium anilide and sodium amide, do not differ essentially in their properties. Both compounds are salts, or, in liquid ammonia, both are ammono bases. Both are dissociated in liquid ammonia and both react with other substances in a similar manner.

It will not be possible to discuss in detail this interesting field that lies in the "twilight" zone between organic and in-organic chemistry. I can only indicate how extensive this field is and point out a few examples. Altogether, there are more than forty elements that form definite compounds with hydro-carbon groups, all of which have a chemistry which is chiefly dependent upon their in-organic constituents. In many respects, these elements will, therefore, have a chemistry that more or less resembles that of oxygen or nitrogen when combined with carbon or hydro-carbon groups. By far, the greater proportion of the elements that form stable compounds with hydro-carbon groups occupy a position in the periodic system either within two groups to the right or within seven groups to the left of the rare gas group. If we arrange these elements in sequence and in periods according to their atomic number, we have the following table:

TABLE I

TABLE SHOWING THE ELEMENTS THAT FORM STABLE COMPOUNDS WITH HYDRO-CARBON GROUPS

1	2	3	4	5	6	7	0	1	2
						H	He	Li	Be
	Be	B	C	N	O	F	Ne	Na	Mg
	Mg	Al	Si	P	S	Cl	A	K	Ca
Cu	Zn	Ga	Ge	As	Se	Br	Kr	Rb	Sr
Ag	Cd	In	Sn	Sb	Te	I	Xe	Cs	Ba
Au	Hg	Tl	Pb	Bi	Po		Rd		Ra

Leaving out the rare gases, which are chemically inert, all the elements in this table are known to form compounds with organic groups with the exception of radium, polonium, and gallium, which have not, thus far, been investigated. On the other hand, aside from these elements, there are only three or four others, namely, chromium, platinum, and, perhaps, iron, that are known to form more or less stable compounds with hydro-carbon groups.

It is evident, from this table, that compounds of the various elements with hydro-carbon groups are formed by almost half of the chemically active elements and by far more than half of the more common elements. These compounds of organic groups with the various elements each have properties that are characteristic of the elements in question, which properties are not primarily dependent upon the carbon groups. These compounds, moreover, enter into many reactions in which the carbon groups are only indirectly concerned. Organic chemists have long made use of the organic derivatives of the halogens and of oxygen, sulfur, nitrogen, etc., and most chemists consider that these compounds are typically organic and that their reactions are typical of organic compounds. This, however, is not strictly true. All these compounds have an in-organic side, so to speak; they have properties that are primarily determined by their in-

organic constituents and these properties, in many instances, are the very ones that render these compounds important. No sharp distinction can be drawn between the organic derivatives of most of these elements. The chemistry of the organic derivatives of oxygen or nitrogen, for example, cannot be differentiated from that of tin, germanium, or boron.

The compounds of these elements with hydro-carbon groups closely resemble the corresponding compounds of the same elements with hydrogen. In general, the order of stability of the hydro-carbon derivatives corresponds to that of the hydrogen derivatives, but the former are usually more stable than the latter. Let us tabulate the hydrogen derivatives of the various elements in the preceding table.

TABLE II

HYDRIDES OF VARIOUS ELEMENTS

3	4	5	6	7	1	2
					LiH	
$(BH_3)_2$	CH_4	NH_3	OH_2	FH	NaH	
	SiH_4	PH_3	SH_2	ClH	KH	CaH_2
	GeH_4	AsH_3	SeH_2	BrH	RbH	SrH_2
	SnH_4	SbH_3	TeH_2	IH	CsH	BaH_2
	PbH_4	BiH_3				

Twenty-seven of the elements of Table I form hydrides. In a given group of the periodic system, the stability of the hydrides decreases as the atomic number increases, while, in a given period, the stability increases with increasing atomic number as we approach the rare gas group from the left and increases in reverse order from the right. Thus, in the 7th group, hydrogen fluoride is more stable than hydrogen iodide, or, in the 5th group, ammonia is more stable than phosphine or the hydrogen derivatives of any other element of higher atomic number in the same group. On the other hand, in the period beginning with silicon and ending with chlorine, for example, the order of stability increases from silicane to hydrogen chloride. So, also, in the alkali metal group, lithium hydride is more stable than cesium hydride. Most of the elements, in the groups beyond the second group, do not form well-defined hydrides comparable, for example, with sodium hydride or calcium hydride.

Referring to Table I, it will be observed that the rare gas group divides the elements into two main divisions. Those to the right are strongly electropositive metallic elements, while those to the left are electronegative, non-metallic elements, although they become more metallic and less electronegative as we recede from the rare gas group. An examination of Table II will show that the hydrides formed by the elements to the right of the rare gas group differ fundamentally in their properties from the hydrides of the elements to the left of this group. The hydrides of the

alkali metals and the metals of the alkaline earths are high melting solids which exhibit the properties of salts. In these salts, the hydrogen acts as negative ion. For example, lithium hydride is a solid melting at 680°. The liquid hydride, as well as the solid at higher temperatures, is an electrolyte, the lithium acting as cation and the hydrogen as anion.

On the other hand, the hydrogen derivatives of the elements to the left of the rare gas group are highly volatile *non-polar*[2] compounds. It is true that the hydrogen derivatives of the halogens exhibit electrolytic properties when dissolved in suitable solvents, such as water, for example, but the pure hydrides themselves do not exhibit electrolytic properties in marked degree. In general, we may say that the hydrogen atoms are attached to these elements by means of non-polar bonds.

Nearly all the elements of Table I, excepting the rare gases, and all the elements of Table II form compounds with hydro-carbon groups and, in general, these compounds are more stable than are the corresponding compounds of the same elements with hydrogen. Nevertheless, these compounds with hydro-carbon groups closely resemble the corresponding compounds with hydrogen. Thus, for example, the alkali metals form compounds with alkyl groups known as the alkali metal alkyls, which are difficultly volatile solids at ordinary temperatures and which, we have reason to believe, are salt-like in their properties. On the other hand, the elements to the left of the rare gas group form volatile non-polar compounds with organic groups and their properties closely resemble those of the corresponding hydrides.

The order of stability of the organic derivatives of the various elements closely parallels that of the corresponding hydrides. Thus, silicane, SiH_4, is stable in the absence of oxidizing agents up to 500°, while plumbane, PbH_4, decomposes even at ordinary temperatures. Correspondingly, tetraethyl silicane is a very stable compound that may be distilled in air and which is oxidized with difficulty, while tetraethyl lead decomposes spontaneously at temperatures slightly above 100°, and is readily oxidized at ordinary temperatures. In general, the organic derivatives of the elements to the left of the rare gas group are much more stable than are the corresponding hydrides, and numerous elements that do not form hydrides form relatively stable organic derivatives.

Just as the hydrides to the right of the rare gas group are salt-like in nature, while the hydrides of elements to the left of that group are non-polar, so, in the case of the organic derivatives, compounds of the alkali metals and alkaline earth metals are salt-like in properties, while com-

[2] In the present discussion the term "polar" is used to designate compounds in which a transfer of electrons occurs and in which then two oppositely charged ionic species exist. The term "non-polar" is thus used in connection with compounds where such a transfer of electrons does not take place.

pounds of all elements to the left of the rare gas group are non-polar. In the case of certain hydrides, and particularly the hydrides of carbon, we may substitute one or more hydrogen atoms by halogens or other atoms. So, in the case of the organic derivatives of the various elements, one or more of the organic groups may be substituted by other organic groups or by elements other than carbon, such as the halogens, oxygen, and even the alkali metals.

It is not possible to enter into a detailed discussion of the numerous compounds formed by these various elements. We may, however, discuss briefly the chemistry of a typical metallic element such as tin. Tetramethyl tin, for example, is readily prepared and 1, 2, 3, or 4 of the methyl groups may be replaced by bromine, for example. We thus have the series of compounds, $(CH_3)_4Sn$, $(CH_3)_3SnBr$, $(CH_3)_2SnBr_2$, CH_3SnBr_3, $SnBr_4$. It is obvious that this series of compounds is closely analogous to corresponding series in the case of carbon. While the chemistry of some of these compounds is very interesting, time forbids our entering into a detailed discussion. It may be pointed out, however, that the compounds of these elements are much more individualistic in their behavior than are the corresponding compounds of carbon. In many instances, it is difficult to predict the nature of the reactions that these compounds will undergo, particularly as one passes from element to element in a given group or a given period.

Let us consider, briefly, the properties of some of these compounds of tin. In the first place, let us return, for a moment, to carbon. I want to bring out the fact that many of these compounds of tin resemble those of carbon very closely. It was formerly supposed that the chaining of carbon atoms was a property characteristic of that element. This, however, is by no means the case. We shall see, presently, that chains of atoms may readily be formed in the case of tin and similar chains may be formed by germanium, silicon, and other elements.

In place of attempting to compare a hydride of carbon with an organic derivative of tin, let us compare a carbon derivative in which the hydrogen has been substituted by carbon groups. Consider, for example, triphenyl methane, $(C_6H_5)_3CH$. It is a very simple matter to prepare the corresponding compound of tin, triphenyl stannane, $(C_6H_5)_3SnH$. Triphenyl methane is much more stable than triphenyl stannane, but its reactions are, in general, very similar. The hydrogen of triphenyl methane may readily be replaced by chlorine, yielding triphenyl methyl chloride, $(C_6H_5)_3CCl$. Similarly, the hydrogen of triphenyl stannane may readily be replaced by chlorine yielding triphenyl stannyl chloride, $(C_6H_5)_3SnCl$. These two compounds are very similar in their behavior. Neither conducts the electric current in the liquid condition, but both are soluble in liquid ammonia and both yield solutions that conduct the electric current. So, also, solutions

of the same compounds in numerous other solvents are electrolytic conductors.

Triphenyl methyl chloride is readily reduced by means of metals, or other reducing agents, whereby triphenyl methyl, $(C_6H_5)_3C$, is formed. Triphenyl methyl is a high melting solid (147°), which, when dissolved in benzene, or certain other solvents, is largely associated to $[(C_6H_5)_3C]_2$. It is readily oxidized by atmospheric oxygen or other oxidizing agents. Similarly, triphenyl stannyl chloride may readily be reduced—for example, by means of sodium in liquid ammonia—whereby triphenyl stannyl, $(C_6H_5)_3Sn$, is formed. Like triphenyl methyl, triphenyl stannyl has a high melting point (226°), and in benzene solution, its molecular weight corresponds to the formula: $[(C_6H_5)_3Sn]_2$. Like triphenyl methyl, triphenyl stannyl is readily oxidized or reduced.

There is this difference between derivatives of tin and derivatives of carbon: while, for example, trimethyl methyl, $(CH_3)_3C$, polymerizes to form the very stable compound hexamethyl ethane, which is not readily split apart by means of oxidizing or reducing agents, the corresponding compound of trimethyl stannyl closely resembles triphenyl stannyl or triphenyl methyl. Hexamethyl stannoethane, $(CH_3)_3Sn\text{-}Sn(CH_3)_3$, is measurably dissociated when dissolved in benzene, particularly at high temperatures, and is readily oxidized and reduced.

Schlenk has shown that, on treating triphenyl methyl with sodium, sodium triphenyl methide, $NaC(C_6H_5)_3$, is formed. This compound is a true salt, as has been shown in this laboratory, being highly ionized in liquid ammonia solution and exhibiting other salt-like properties. Similarly, when trimethyl stannyl, or triphenyl stannyl, is treated with sodium, the corresponding compound, $NaSn(CH_3)_3$ or $NaSn(C_6H_5)_3$, is formed. Sodium trimethyl stannide and sodium triphenyl stannide are stable salts, readily soluble in liquid ammonia and highly ionized in that solvent. Indeed, the ionization of compounds of this type is markedly higher than that of ordinary salts.

Corresponding derivatives of many elements other than tin may be formed. In the case of germanium, even sodium germanyl, $NaGeH_3$, may readily be obtained by the action of sodium on germane, GeH_4, in liquid ammonia. Sodium germanyl is a close analog of sodium methyl, $NaCH_3$. It, however, has the remarkable and useful property that, unlike sodium methyl, it is comparatively stable toward hydrolyzing agents. Sodium germanyl forms stable solutions in liquid ammonia.

If we reduce dimethyl tin dichloride, $(CH_3)_2SnCl_2$, with sodium in liquid ammonia, we may form the divalent free group, $(CH_3)_2Sn$, or, on further reduction, the salt, disodium dimethyl stannide, $Na_2Sn(CH_3)_2$. Compounds such as this are of importance in synthesizing the more complex metallo-organic derivatives of tin and other elements. Let me illustrate

how this compound may be employed in the synthesis of a chain of tin atoms. Let us, for example, synthesize dodecamethyl stannopentane, $Sn_5(CH_3)_{12}$. If one molecule of dimethyl tin dichloride is treated with 4 atoms of sodium, reaction takes place according to the equation:

$$(CH_3)_2SnCl_2 + 4Na = Na\,Sn(CH_3)_2\,Na + 2NaCl.$$

If the resulting solution of disodium dimethyl stannide is treated with dimethyl tin dichloride, in the proportion of 2 mols of the former to 1 mol of the latter, reaction takes place as follows:

$$Na\,Sn(CH_3)_2\,(Na + Cl)\,Sn(CH_3)_2\,(Cl + Na)\,Sn(CH_3)_2\,Na = Na\,Sn(CH_3)_2 - Sn(CH_3)_2 - Sn(CH_3)_2\,Na + 2NaCl.$$

Disodium hexamethyl stannopropane is formed and if, now, the resulting solution is treated with trimethyl tin chloride, 1 mol of the former to 2 mols of the latter, the following reaction occurs:

$$CH_3Sn(CH_3)_2\,(Cl + Na)\,Sn(CH_3)_2 - Sn(CH_3)_2 - Sn(CH_3)_2\,(Na + Cl)\,Sn(CH_3)_2 - CH_3$$

$$= CH_3 - Sn(CH_3)_2 - Sn(CH_3)_2 - Sn(CH_3)_2 - Sn(CH_3)_2 - Sn(CH_3)_2 - CH_3 + 2NaCl.$$

Sodium chloride is split out, the corresponding tin atoms are linked together, and dodecamethyl stannopentane is formed as the final product of the reaction. In a similar manner, corresponding butanes and propanes have been prepared, as have also certain compounds in which silicon or germanium are linked to tin.

To summarize, the in-organic side of organic chemistry comprises the study of the characteristic properties and reactions of atoms which have carbon groups attached to them. The number of elements that form stable compounds with carbon groups is extremely large and the chemistry of these compounds is both varied and interesting. The further study of the metallo-organic compounds, as they are called, gives promise of yielding many interesting results that should prove of value to the in-organic as well as to the organic chemist.

Be intensely in earnest. Enthusiasm invites enthusiasm.—R. H. CONWELL

AEROSOLS—CLOUDS, DUST, FOG, AND SMOKE

WILLIS J. BRAY, STATE TEACHERS' COLLEGE, KIRKSVILLE, MISSOURI

Among all of the disperse systems which man has studied none, perhaps, occupies a more important place in the economy of nature than those in which a liquid or a solid phase is dispersed in a gas phase. Originally called dispersoids, the term aerosol has more recently been applied to them, partly through their analogy to disperse systems in water, which are often called hydrosols, and partly because the name is in harmony with the recent developments in the science. Under this heading are included clouds, fogs, dust, mist, and smoke. In such a heterogeneous system, with a gas dispersion medium, we should expect to find a good many characteristics not found in any other form of colloid. Here temperature, pressure, and concentration may all vary to produce more or less profound changes in the substance. However these qualities may vary, it appears that variations in the dispersion medium may be brought under the phase rule in that they all have to do with the molecular kinetic energy of the system. In such a system, the molecules of the gas have a relatively large mean free path, possibly three hundred times the diameter of the particle of the disperse phase, or of the molecule of the gas itself. The molecules of the gas are, therefore, so far apart that they are beyond the reach of intermolecular cohesion, and they might be expected, therefore, to move in straight lines. Under such conditions the molecules would collide in such manner as to re-evaporate as rapidly as they condense as a result of the collision, if no other factor were present to interfere.

There are several important differences between an aerosol and other colloidal solutions. One of the most important of these is the fact that the viscosity of the dispersion medium is relatively small so that the dispersed particles tend to settle more rapidly than the particles of the same size would in a more viscous medium. Since, in aerosols, the molecules of gas move with greater velocity through a longer mean free path, we should expect that Brownian movement would be quite different from what would be found in other types of colloidal systems. In an aerosol, also, the particles do not, necessarily, all bear the same charge. The particles may be neutral, or charged positively or negatively, or, under certain conditions, in all three states at the same time, some particles being in one condition and some in another. The particles of dispersed phase may be so large that they exhibit no Brownian movement, as in the case of clouds. Under other circumstances the particles may be smaller and do exhibit Brownian movement in the regular way, as in the case of smokes. The structure of aerosols is more simple than that of any other type of colloid, since it is impossible to get very concentrated systems, due to the relative ease of flocculation.

There are two ways in which aerosols may be formed. One is the condensation of a gas or vapor in the presence of suitable nuclei, and the other is the disintegration or dispersion of a solid or a liquid in a gas dispersion medium.

Condensation occurs when the molecular kinetic energy of the system is decreased to a certain point. At this point the probability of adhesion approaches unity. This may be accomplished by the adiabatic expansion of the system to reduce the kinetic energy of the individual particle, or by cooling. In either case the gas becomes more and more highly saturated until condensation begins to take place around dust particles, smoke particles, or even gaseous ions which may be present. A good example of the formation of an aerosol by adiabatic expansion is seen in the exhaust from an internal combustion engine. The water is seen to condense on particles present to form a fog or a cloud. Water condenses most readily upon negatively charged nuclei,[1] while the majority of other vapors condense most readily upon positively charged nuclei. In general, it may be said that a dispersion in a gas will condense when the kinetic energy of the molecules of the system becomes less than the forces tending to disrupt them. If suitable condensation nuclei do not exist it is necessary to have a much higher degree of supersaturation before an aerosol will be formed. The size of droplets during condensation varies from 200 micra to 20 micra, as the ratio V_2/V_1 increases from 1.25 to 1.34. Gibbs says that, for expansions of from V_2/V_1 1.25 to 1.28 the water vapor condenses only on negative ions, while for a ratio of from 1.28 to 1.34 it condenses only on positive ions.[2] When the degree of saturation reaches 1.4 cloudy condensation occurs, which continues with coarse condensation after 1.43. When a ratio of 1.46 is reached the radius of the droplet is about 0.6 micron. Gibbs says that condensation of the particles is found possible only when the radius of the particle is greater than 0.63 millimicra. Water vapor is said to be peculiar in that, at a supersaturation of 4.2, it condenses on negative ions, while, at S = 6.0, it condenses exclusively on positive ions.[2] The character of condensation depends, in part, also, on the hygroscopic character of the nuclei. The more pronounced the hygroscopic character the more stable the aerosol. This may easily account for the fact that a fog over a city is often more persistent and more stable than one over rural districts, since, in the former case, particles of sulfuric acid might easily act as nuclei.

An aerosol may also be formed by mechanical dispersion. This may take the form of spraying a liquid under high pressure, by grinding or by detonation. All are familiar with the principle of dispersion by spraying.

[1] Gibbs, "Clouds and Smokes," J. & A. Churchill, London, **1924.**

[2] Gibbs, "Aerosols," in Alexander's "Colloid Chemistry," Chemical Catalog Co., New York City, **1926.**

Cement mills are now making use of the mechanical dispersion of a solid in air when they grind the cement and form it into an aerosol and pump it through pipes from one part of the plant to another. This process of dispersion is often employed in chemical warfare.

In an aerosol the primary degree of dispersion is always high, gradually diminishing as the particles collide and coalesce. This gradually decreases Brownian movement from a state of great activity to zero. A condition is gradually reached when the probability of collision is very low producing a relatively stable sol. It is rendered even more stable in this condition, when the probability of collision approaches zero if, by the adsorption of a film of gas, the probability of adhesion of the particles also approaches zero. This represents the condition of maximum stability of an aerosol.

There are two kinds of forces tending to produce movement of the particles in an aerosol. One is entirely extraneous to the system and includes such forces as gravity, centrifugal force, and an electrical field. The other is the Brownian movement.

If the particles are larger than the mean free path of the gas molecules the ultimate constant velocity of the particle will be:

$$V = \frac{9}{2} r^2 \frac{(p - p^1)g}{\eta}$$

in which p is the density of the particle, p^1 the density of the fluid, r the radius of the particle, η the viscosity, and g the gravitational constant. By means of this formula the velocity of the particles can be calculated.

If the particle is moving under the influence of an electric field the velocity may then be calculated from the following formula, where x is the strength of the field, and e is the charge:

$$V = \frac{Xe}{6\pi\eta r}$$

Using this formula Stokes calculated the rate at which drops of water of which clouds are formed sink in air. In this case, using the first formula mentioned above, p is unity, p^1 is negligible, the viscosity is 1.81×10^{-4} c. g. s. units, so that V becomes $12 \times 10^5 \times r^2$ cm. per second. For very small cloud particles the rates of fall were found to be as follows:

TABLE I

Radius of droplet	Rate of fall, cm. per sec.
10^{-2}	120 (4320 meters per sec.)
10^{-3}	1.2 (43.2 meters per sec.)
10^{-4}	12×10^{-3} (43.2 cm. per hr.)
10^{-5}	12×10^{-5} (4.32 mm. per hr.)

It was found that non-spherical particles fall in such a manner as to encounter a maximum of resistance in falling. Thus, ice crystals fall with

their long axis horizontal. Lord Rayleigh found that the Stokes Law no longer holds when the radius of the particles exceed 10^{-2} cm., since the drops, under such circumstances, would fall as rain.

A particle smaller than 10^{-5} cm. has a diameter smaller than the mean free path of the molecules, and will tend to slip in between the molecules of the gas. Both Cunningham and Millikan have calculated that, in such a case, the particles will be impelled by a force greater than that which would be expected according to Stokes' Law.[3] In such a case it was found that the velocity of the particle would be:

$$V = V^1\left(1 + K\frac{\lambda}{r}\right)$$

where V is the true velocity, V^1 the velocity according to Stokes' Law and r the radius of the particle, K is a constant (about 0.86) and λ the length of the mean free path of the gas molecules.

Millikan's work with oil droplets sprayed into a compartment in which the behavior of the particle could be observed is noteworthy. He provided a pin-hole through which an oil droplet could fall into an observation chamber in which the force of gravity could be overcome by that of an electric field. By means of this device he was able to study the rate of fall of the droplet under varying conditions of pressure. Table II shows how the values of V thus obtained differ from those calculated directly from the Stokes formula. It is seen from this table that the larger the droplet the greater the error in calculating the velocity from the Stokes' formula.

TABLE II

V from Stokes formula	V from Stokes-Cunningham formula
1×10^{-4}	1.14×10^{-4}
1×10^{-5}	2.57×10^{-5}
1×10^{-6}	4.5×10^{-6}
1×10^{-7}	17.0×10^{-7}

One can calculate the diffusion of a particle of an aerosol by means of the following formula:

$$D = \frac{1}{2}\frac{RT}{r}\frac{1}{3\pi\eta r}$$

It is easily seen, from this formula, that the smaller the particle of disperse phase the more rapid will be its rate of diffusion, and that, in all cases, their rate will be much lower than that of the gas molecules having a much smaller radius.

Brownian movement in an aerosol, having particles small enough to exhibit such phenomenon, exceeds that in a liquid due to the fact that the network of gas structure in an aerosol is so open that the gas molecules, with their relatively large mean free path, exert a greater pressure on the

[3] Millikan, *Trans. Am. Electrochem. Soc.*, **5**, 185 (1921).

particles of the disperse phase than could be in a system dispersed in a liquid.

Gibbs says[1] that, in a colloidal system in which a liquid is the dispersion medium, the following facts may be observed:

1. A particle in Brownian movement moves with uniform velocity. (*Svedberg*)
2. Smaller particles move more rapidly than large ones. (*Exner*)
3. Particles in a concentrated system move more rapidly than those in a more dilute one. (*Zsigsmondy*)
4. Particles travel more rapidly as the viscosity of the medium is diminished. (*Svedberg*)
5. At constant viscosity the amplitude of motion is directly proportional to the absolute temperature. (*Seddig*)
6. Owing to the small but continuous influence of gravity upon the motion of the particles, they gradually arrange themselves so that their concentration is greatest in the lowest layer, and diminishes progressively upward. (*Perrin*)

All of these experimental observations are found to be in agreement with the Einstein formula. Theoretically this expression should hold for particles suspended in a gas.

Whatever deviations there may be from a literal application of these observations in the case of aerosols may be due to the fact that the latter change in density and volume with even slight changes in temperature, and to the further fact that it is very difficult to get air that is sufficiently free from convection currents to make accurate measurements in aerosols.

In 1906 Smoluchowski, a brilliant young Russian mathematical physicist, showed that particles suspended in a gas should show Brownian movement, as had been previously asserted in 1881 by Bodaszewski. This displacement of a suspended particle in the air at ordinary temperature and pressure was found to be eight times as great, and in hydrogen fifteen times as great, as in water. The displacement increases with the decreasing pressure. The calculations of Smoluchowski were confirmed by experimental data obtained by Ehrenhaft,[4] working with cigarette smoke and with ammonium chloride vapors, and by De Broglie[5] working with metallic smokes. Millikan, likewise, by an elaborate experiment, showed that the Einstein formula holds for Brownian movement in aerosols.[3] The Einstein expression may be written as follows:

$$\text{Amplitude of motion, } A = \sqrt{\frac{RT}{N} \cdot \frac{t}{3\pi\eta r}}$$

It was shown by Ehrenhaft that small particles, 10^{-4} cm. to 10^{-6} cm., suspended in a gas are attracted or repelled by a bright light such as that coming from a powerful arc. This phenomenon is called photophoresis. It seems that the question of whether a particle will exhibit positive or

[4] Ehrenhaft, *Phys. Z.*, **16,** 227 (1916).
[5] De Broglie, *Compt. rend.*, **148,** 1315 (1909).

negative photophoresis depends upon its capacity for absorbing radiant energy.[1] So far as is known to the author, no one has ever made a study of the influence of photophoresis from the sun on aerosols.

In general, the stability of aerosols may be considered comparable to that of other colloidal systems. A fog or a cloud may persist for days, and a smoke may travel a long distance without diffusing or flocculating so much as to destroy it. The stability of an aerosol depends, in part, upon its degree of dispersion. Stability occurs when, at the stage of arrested flocculation, the particles become surrounded with a layer of adsorbed gas, lowering the probability of adhesion, and, also, when all particles are charged similarly. The stability of an aerosol, therefore, depends upon, or is related to, evaporation, settling, diffusion, and flocculation. Since vapor pressure of an aerosol, such as fog, increases as the radius of the particle decreases, evaporation from such a system may be very high, due to the very large specific surface. In this case the smaller droplets disappear to reprecipitate on the larger ones until there is ultimately complete flocculation, unless some of the factors making for stability should intervene. One factor definitely making for instability of an aerosol is agitation. Thus a cloud may be flocculated by wind, unless protected by adsorbed gas.

Most particles of an aerosol carry one unit charge of electricity, if, in fact, the particle is charged at all. Gibbs[6] gives the following summary of what may be expected of the various types of clouds and smokes, as to the character of the charge on the particle:

> Particles may become charged by friction with the dispersion medium.
>
> This would seem to be similar to the Dorn effect, since dust blown about in the air becomes charged, the charge varying with the composition of the dust as follows:
>
> *a.* Non-metallic dust becomes positively charged.
> *b.* Metallic dust becomes negatively charged.
> *c.* Acid forming dust becomes positively charged.
> *d.* Dust of basic forming oxides becomes negatively charged.

In a sandstorm, the particles are charged positively due to the property of silicon dioxide just mentioned. In England dust is largely due to calcareous substances, and, hence, the dust is negatively charged. Thus, many an automobile is stalled in a sand storm because of this phenomenon.

When rain drops, falling through the air, are broken up by resistance of air, the drops become positively charged and the surrounding air becomes negatively charged. In the same way, the particles of water at a waterfall become electrically charged. Steam, suddenly expanding through an orifice, becomes positively charged.

Charged smoke or dust particles, passing close to some metallic surface, change their direction and fly to the metallic surface. This has been util-

[6] Gibbs, "Disperse Systems in Gases," 4th Report on Colloid Chemistry, *Bull. Am. Assoc. Adv. Sci.*, **1921.**

ized in industrial plants as a means of settling dust, particularly metallurgical dust. It has been shown that fresh tobacco smoke, when examined between charged plates under a microscope, shows that some of its particles are positively charged and some negatively charged. Such a condition promotes flocculation, and so the blue colored smoke first seen quickly changes to a white smoke having larger particles, with all particles similarly charged. Byersdorfer[7] has shown that accumulations of inflammable dust carrying static electrical charge is a direct cause of explosions. This point will be more fully discussed later.

When a substance is dispersed in a gaseous medium its specific surface, as has been already said, becomes very large. This means that, whatever of chemical reactivity the dispersed phase may have is greatly increased by the subdivision. This is directly related to dust explosions, as will be shown later. This chemical reactivity may be either with the dispersion medium or with some other part of the system. In many cases the chemical activity of the disperse phase is very greatly increased by adsorbed oxygen, and, in other cases, it may be decreased by the adsorption of inert gas. If an aerosol is explosive or combustible at all, the substance dispersed as a smoke or a cloud should be much more so.

It has been found that almost any organic material, when in the form of an aerosol, may undergo spontaneous combustion or explosion when raised to the proper minimum temperature. The following table by Wheeler[8] gives this data for several substances:

TABLE III

Nature of dust	*Min. temp. at which can be ignited*	*Min. temp. at which it will ignite and propagate flame, Degrees C.*
Sugar	540	850
Dextrin	540	940
Starch	440	960–1035
Grain	630	995–1050
Flour	650	1060

In connection with these data it is interesting to consider the data by Dixon and Coward[9] as shown in Table IV giving temperatures at which mixtures of various gases in air will ignite.

On the basis of this study Wheeler classified all such substances into two classes. The first may be lighted by a match, and includes sugar, starch, rice meal, wood flour, malt, oat husks, grain, corn, rape seed, corn flour, and flour. The second consists of those substances which require stronger

[7] Byersdorfer, *Koll. Zeit.*, **1923,** 101–7.
[8] Wheeler, *Chem. & Met. Eng.*, **24,** 29–33 (1921).
[9] Dixon and Coward, *Trans. Chem. Soc.*, **95,** 514 (1909).

TABLE IV

Nature of gas	Ignition temperature
Carbon monoxide	644–658°C.
Hydrogen	580–590
Ethylene	542–547
Methane	560–750
Ethane	520–630

heating, such as the flame of a Bunsen burner to ignite, and includes rice millings, castor oil meal, bran grindings, grist milling, corn meal, and mustard. A third class might be added which would propagate a flame. This would include spice, cotton seed, slack cleaning, Russian rape seed, grain cleanings, and coal dust. The velocity of flame propagation of such mixtures varies from 2000 to 6000 feet per second, as compared with 9250 feet per second in the case of a mixture of two parts of hydrogen and one part oxygen.[10] Such explosions can be avoided or prevented by preventing the dust accumulations, avoiding ignition, increasing the humidity of the air, diluting the dust with non-inflammable dust, and diluting the air with inert gas.

There are many industrial establishments which have dust problems of large proportions. Industrial aerosols may be divided into three classes on the basis of the size of particles as follows: dusts having size of particles ranging from 10^{-3} cm. up; those from 10^{-3} to 10^{-5} cm.; and those from 10^{-5} to 10^{-7} cm., the classes being dusts, clouds, and smokes, respectively. Gibbs gives a table classifying certain dusts and smokes on the basis of size of particle:[1]

TABLE V

Substance	Diameter of particle in cm.
Milk powder by evaporation of spray	1.4×10^{-2} to 0.7×10^{-2}
Fine powder, 300 mesh, *e. g.*, cement	1.0×10^{-2} to 0.7×10^{-2}
Smelter fumes	1.0×10^{-2} to 1.0×10^{-5}
Atmospheric fog	1.4×10^{-3} to 3.5×10^{-3}
Cement kiln dust from flues	6.0×10^{-3} to 0.8×10^{-3}
H_2SO_4 mist from evaporators	1.1×10^{-3} to 1.6×10^{-4}
NH_4Cl fumes	1.0×10^{-4} to 1.0×10^{-5}
Oil smoke	1.0×10^{-4} to 5.0×10^{-6}
Rosin smoke	1.0×10^{-4} to 1.0×10^{-6}
Tobacco smoke	1.5×10^{-5} to 1.0×10^{-6}

In certain cases, such as the dusts, a portion of the suspended matter may be removed by settling. One method of settling is to retard the rate of flow of the gas to permit the larger particles to settle. Centrifugal methods may be employed. Contact with solid surfaces is effective in certain cases,

[10] Price, D. J., "Some Phases of the Work of the Bureau of Chemistry on Dust Explosions in Industrial Plants," *J. Chem. Educ.*, **3**, 1008–17 (Sept., 1926).

while, in other cases, the gas is filtered to remove suspended particles. All of these methods, including washing, will not be effective in all cases. In such cases the Cottrell precipitator is very effective. It is an invention of Dr. F. G. Cottrell, who, while studying methods of flocculation of sulfuric acid mist, devised a scheme of electrostatic precipitation. Either alternating or direct currents may be used. The subjection of the gas to a high voltage causes some of the gas to be ionized and the particles of the disperse phase to become electrically charged. The flocculation then progresses rapidly. In most industrial plants having large volumes of aerosols to treat, it is found best to use the direct current, since it drives the particles directly to the proper electrode. The essential unit, says Gibbs, consists of a wire passing down the center of a long metal pipe. The wire is charged negatively, the pipe being grounded. The gas to be treated passes through the pipe. The voltage used varies from 20,000 to 100,000 volts and the potential gradient across the treater pipe varies from 4000 to 5000 volts per centimeter. The gas moves at from 5 to 6 feet per second. The process has been used in many industries and has been found quite profitable to the industry and valuable from hygienic considerations to the community and to the employees. It is by far the most effective method yet devised for this purpose.

The United States Bureau of Mines, which has been largely responsible for all work on coal dust explosions in America, has found that the velocity of the explosion increases as it is propagated through the mine, and that pressures as high as 120 pounds per square inch have been measured at right angles to the direction of the propagation. Not the least interesting of the devices suggested to check the advancing wave of explosion in a coal mine is a mechanism which is tripped automatically by the advancing wave of explosion, and a cloud of fine rock is liberated in the form of a screen across the path of the advancing wave.

Coal smoke in the air forms a real menace to health in many cities. It is said that Pittsburgh, a city formerly noted for its smoke-laden air, has had a very high death rate from pneumonia. They have largely solved their smoke problem by more efficient methods of combustion of fuel and have, therefore, solved an important health problem. It has been shown that air over a great city may have as many as 300,000 dust particles per cubic centimeter. Two thousand particles per cubic centimeter will obscure distant objects five miles away, while 100,000 per cubic centimeter will obscure objects one mile away.

Dew, frost, rain, snow, sleet, and hail are all formed from the dispersion of water vapor in air under varying conditions of temperature and pressure. During wet weather falling rain or snow brings down particles which were either positively or negatively charged and thus carry down from the air to the ground (if they are positively charged) and from the ground up if it

is negatively charged, in a sort of system of convection currents.[1] Such currents, according to Gibbs, rarely exceed one milliampere per square kilometer. During a thunder storm the potential must approach 30,000 volts before a lightning flash will occur. The current during a flash of lightning is about one ampere. The e. m. f. between the base and the summit of the thunder cloud may be as much as 10^6 volts, so that the discharge may take place directly from cloud to cloud or by way of earth to cloud.

The World War brought out a new type of defensive agent in the form of smoke. It also becomes an effective offensive agent when toxic smokes are employed. In warfare smoke is generally employed as a means of screening a given area from observation by the enemy. Under such conditions it is highly desirable that the agent employed have a maximum of total obscuring power (T.O.P.). This T.O.P. is measured by means of a large box having a 25-watt light in it. The smoke is introduced into the box and the depth of smoke at a certain concentration necessary to obscure is the T.O.P. of that smoke. The most effective agent for this purpose is phosphorus pentoxide. It is effective because of its ready hydration and the ease with which it diffuses the light rays makes it superior to all others since it has a maximum of effectiveness at a minimum of concentration. The white phosphorus used for this purpose is fired from various weapons in shells, hand grenades, rifle grenades, Stokes mortar shells, and Livens projector shells. The bursting of the shell scatters the phosphorus and it immediately bursts into flame. The smoke produced absorbs water readily and, being heavy, hugs the ground, giving very effective screening. The bursting projectile may scatter the burning phosphorus over an area varying from a few square yards to many square yards. Stannic chloride and titanium chloride are also used for screening smokes, but are inferior to white phosphorus smoke.

Coal smoke is used by the navy for screening operations, but this is decidedly inferior to phosphorus pentoxide in T.O.P., since the latter depends upon merely scattering the light rays, while the coal smoke depends on the absorption of the light rays. The former can be accomplished at lower concentration. The bursting of a white phosphorus shell or grenade also acts as an incendiary agent if there is anything combustible in the vicinity. Smoke candles are also an effective means of laying down a smoke screen. In all of these cases the effectiveness depends largely upon atmospheric conditions.

Toxic smokes most commonly used are diphenylchlorarsine and diphenylaminechlorarsine. The former is persistent for about ten minutes and the latter for perhaps no longer a time. The persistence of toxic smokes being low, they are of limited value.

Among the aerosols employed in warfare may be mentioned mustard

gas. It is a liquid which is dispersed by detonation, or, more recently, it is arranged to be sprayed by aircraft with great effectiveness. It does not remain dispersed but settles out quickly. It is a most effective agent of either defense or offense. Its chief value is as a vesiccant, producing serious burns to one not protected against it.

Asphalt and Steel Pavement to Be Tried in Paris. Surfastal, a new pavement laid under British patent, and already said to be a success in England, is soon to be given a trial in Paris, according to advices from Consul Raymond Davis, Paris. The *Société Surfacier*, the company holding the rights to this process in France, claims that the pavement is particularly adapted to city uses. It maintains that ordinary asphalt and concrete pavements, although greatly improved in quality during recent years, are still incapable of standing up satisfactorily under certain conditions, as, for example, a rapid and intense circulation, the stops and departures of heavy autobuses, sharp turns, and heavy loads.

Surfastal, as it will be laid in Paris, will consist of a concrete foundation about 6 inches in thickness, upon which is poured a 0.5-inch layer of asphalt. A steel trellis or framework is then placed upon the asphalt, composed of strips 1 inch in height, 0.125 inch in thickness, and forming squares of about 5 inches on the side. To prevent displacing before completion of the surface, each square is connected by steel pins. When this trellis has been set in place, the squares are filled with asphalt and the resulting surface is thus divided into a series of small squares, bounded on each side by strips of steel, connected by steel pins. Since the framework is sufficiently flexible to conform to the profile of the foundation, it becomes an integral part of the wearing surface. The weight of heavy loads, therefore, is supported by the steel framework distributed over a considerable surface area, and the wear on the asphalt is never more than the wear on the edge of the steel strips, thus reducing maintenance cost to a minimum.

When asphalt or concrete is used in the surface layer, the material contained in each square extends under the steel framework to the contiguous squares and forms a homogeneous mass, separated on the surface only by the steel strips to a depth of 1 inch.

While Surfastal could, of course, be employed for entire sections of city pavement, it would appear to be of the greatest value for certain specified uses.—*Ind. Eng. Chem.*, **21,** 125 (Feb., 1929).

Commercial Uses for Bentonite. As a result of investigations conducted by the Bureau of Mines, it is announced that extensive commercial uses will probably be found for bentonite, one of the oldest and least known mineral substances. Certain bentonites have such strong affinity for water that they are capable of absorbing more than ten times their volumes of water. Owing to its peculiar physical properties, bentonite has been suggested as a component material in the manufacture of commodities as diversified as paper, rubber, putty, phonograph records, pencil leads, and soaps. On the other hand, underground deposits of bentonite have caused great difficulties in the drilling of oil wells, it frequently becoming necessary to take special steps to combat the nuisance. Bentonite contains 75 per cent or more of the crystalline clay-like minerals, montmorillonite or beidellite.

A large number of samples of bentonites from many sections of the United States were studied in the course of the investigation.—*Ind. Eng. Chem.*, **21,** 133 (Feb., 1929).

CHEMICAL EDUCATION IN MINNESOTA*

R. E. KIRK, UNIVERSITY OF MINNESOTA, MINNEAPOLIS, MINNESOTA

Three hundred high schools in the state of Minnesota offer instruction in chemistry. Nearly all of these schools have adequate laboratories. The rise and development of the "consolidated schools" has added greatly to the number of high schools that can afford adequate facilities for instruction in chemistry. In many of the smaller rural high schools the work in chemistry is related very closely and effectively with the work in agriculture and home economics. The teacher is often the same and the subject matter is consequently well coördinated. The large high schools of the Twin Cities, Duluth, and the towns "on the Range" boast handsome buildings and spacious and well-equipped laboratories. The teachers in these schools are usually specialists in chemistry.

Some twenty-one junior colleges in Minnesota are listed as offering one or more courses in chemistry. Local conditions in many of the towns and cities of Minnesota are such as to favor the growth of junior colleges. In many of these institutions courses are being given in general, analytical, and organic chemistry.

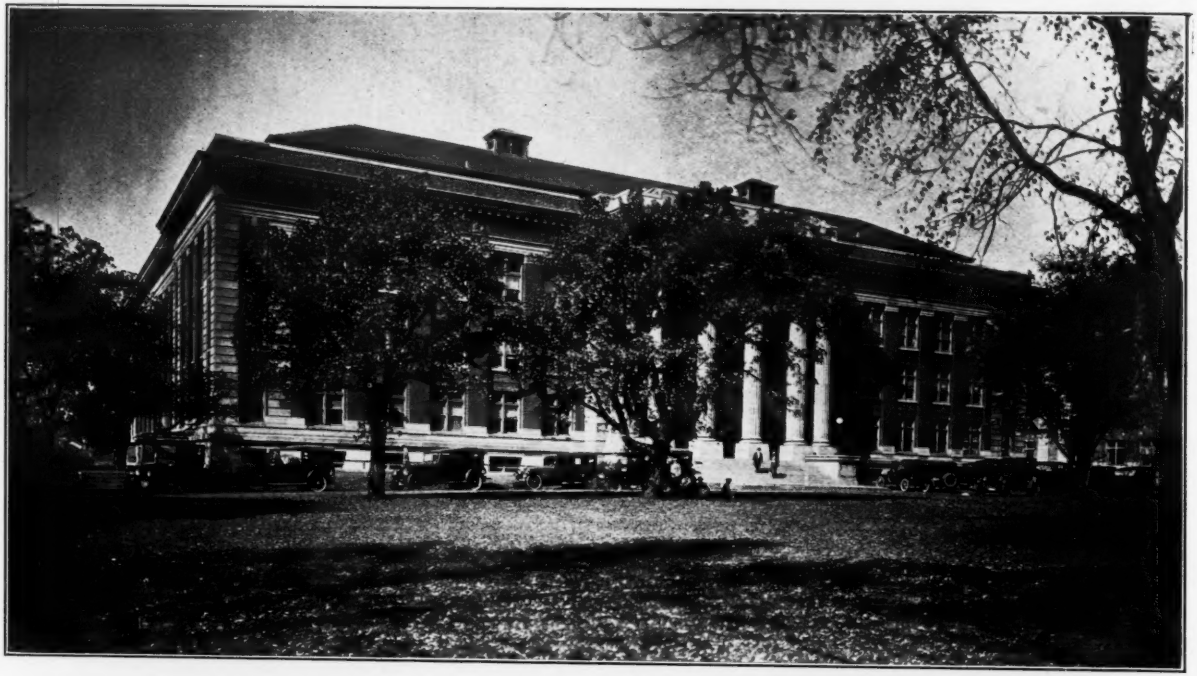
The State of Minnesota supports six state teachers' colleges. In these the instruction in chemistry is adapted to the needs of the teachers being trained.

There are some twenty independent institutions of collegiate rank located in the state of Minnesota; nearly all of these offer systematic courses in chemistry. In many of them, a student may major in chemistry for the bachelor's degree. For instance, each of the better known colleges of the state—Gustavus Adolphus College at St. Peter, Carleton College and St. Olaf College at Northfield, and Hamline, Macalester, and St. Thomas at St. Paul—offers a well-organized sequence of courses in chemistry.

The University of Minnesota has many and diverse interests in chemistry. The School of Chemistry serves as a center for most of the formal instruction in chemistry for students who are not specializing in chemistry. Curricula are also maintained leading to the bachelor's degree in chemistry and in chemical engineering. The school is organized into six divisions, those of inorganic, analytical, organic, physical, technological, and chemical engineering.

The College of Pharmacy offers a curriculum leading to a degree in pharmaceutical chemistry and the medical school offers instruction in physiological chemistry and in pharmacology.

* This article is timely because of the approaching Fall Meeting of the American Chemical Society in Minneapolis, the week of September 9th.



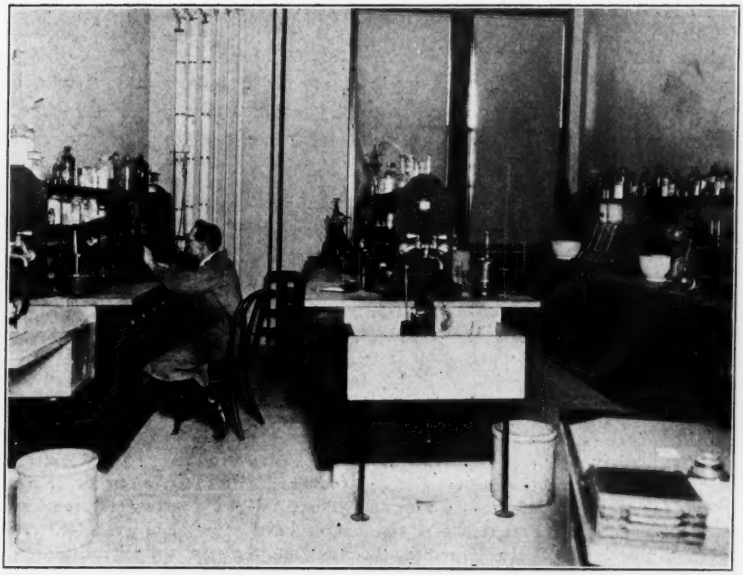
SCHOOL OF CHEMISTRY, UNIVERSITY OF MINNESOTA
The University is anticipating a large and enthusiastic meeting of the American Chemical Society this fall.

Main Auditorium, School of Chemistry, University of Minnesota

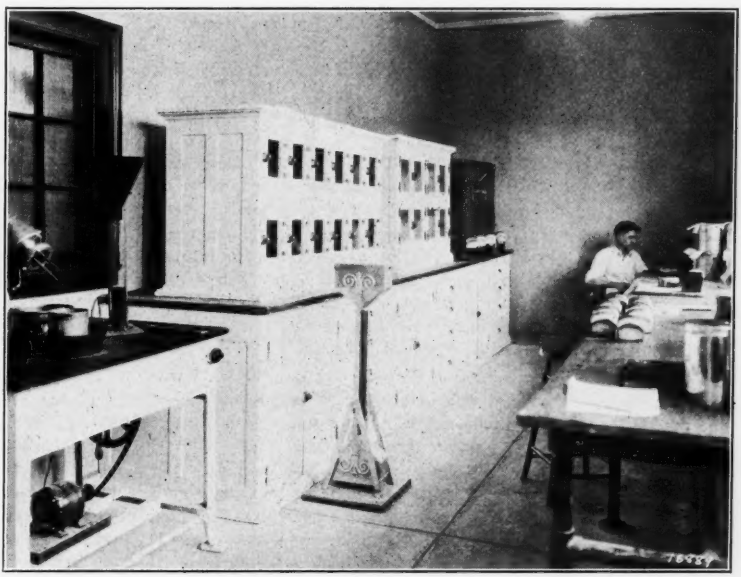
Library, Chemistry Building, University of Minnesota

ONE OF THE RESEARCH LABORATORIES, UNIVERSITY OF MINNESOTA

A VIEW OF THE CHEMICAL ENGINEERING LABORATORY, UNIVERSITY OF MINNESOTA



RESEARCH LABORATORY, NEW AGRICULTURAL BIOCHEMISTRY BUILDING, UNIVERSITY OF MINNESOTA



BAKING LABORATORY, NEW AGRICULTURAL BIOCHEMISTRY BUILDING, UNIVERSITY OF MINNESOTA

The Division of Agricultural Biochemistry in the Department of Agriculture offers a curriculum in agricultural biochemistry and in addition teaches service courses above the first-year level for other students in that department. In addition, the Department of Agriculture maintains chemistry courses in three secondary schools of agriculture.

Graduate work in chemistry is administered by the graduate school and utilizes the faculties of the several units referred to as well as the members of the investigational staffs.

The investigational work of a chemical nature of the University includes that of the Agricultural Experiment Station in soils and in biochemistry, the Mines Experiment Station, the Engineering Experiment Station, the Medical School, and the Mayo Foundation.

Sterilization of Swimming Bath Water. With regard to the fact that by sterilization with a measured trace of chlorine gas, combined with other treatment, it is now possible to operate swimming baths for many months with the same water, some interesting chemical and bacteriological test figures have been made available. These relate to the Hoxton Baths, Shoreditch (London), and represent the water after a summer season's running, equal to use by about 100,000 bathers.

The instalaltion comprises a first-class bath with a capacity of 140,000 gallons, and a second-class of 79,000 gallons. The contents of both baths are circulated, respectively, through the purification plant at the rate of 23,400 and 13,200 gallons per hour. All the equipment has been supplied by the Paterson Engineering Co., Ltd. After the season's running the ammoniacal nitrogen in the first-class bath is 0.0026 part per 100,000, and in the second-class bath 0.0040, while the corresponding figures for albuminoid nitrogen are 0.0094 and 0.0140. The "nitrous" nitrogen is nil, indicating the absence of organic material, and the "nitric" nitrogen is 0.730 part per 100,000 in both cases. There is no trace of free chlorine, the chlorides are only 5.10 and 5.30 per 100,000, respectively, while the total CO_2 is 37.0 and 36.0, of which 1.20 and 1.80 are "free" CO_2. The water is perfectly clear, equal in color to average good quality drinking water, neutral in reaction, and without smell, while the total hardness is 24.5°, London town water supply being, of course, very high in this respect. As regards the bacteriological analysis in both baths, *Bacillus Coli communis* and *Bacillus Enteritidis sporogenes* are entirely absent in 100 cc. The total number of colonies per cc. capable of growing upon nutrient gelatin at 20°C. in 3 days is 6 in the case of the first-class bath and 10 for the second-class bath, while in each case 2 colonies only were grown upon agar jelly at 37°C. in one day.—*Chem. Age*, **20**, 336 (April 6, 1929).

Sulfur from Canadian Smelter Plants. Professor M. C. Boswell, of the faculty of applied science in the University of Toronto, is said to have developed an important new process for the extraction of sulfur from the sulfur dioxide gas produced in Canadian metallurgical plants. At present three million dollars' worth of sulfur is brought annually into Canada, the greater portion of which is used by the pulp and paper industry. Should Professor Boswell's discovery lead to the economical production of sulfur, the benefit, not only to the mining industry, but also to the pulp and paper industry, would be very great. It is believed that as much as six or seven per cent of the fumes from Canadian smelters consists of sulfur dioxide, the effect of which on surrounding vegetation is very serious.—*Chem. Age*, **20**, 388 (April 20, 1929).

CHEMICAL EDUCATION IN IOWA HIGH SCHOOLS

RICHARD ALLEN WORSTELL, FORT MADISON HIGH SCHOOL, FORT MADISON, IOWA

The burden of imparting the first principles of chemistry to the American people in the future seems to rest largely with the chemistry teachers of our high schools throughout the land. Through no other organized means will the bulk of the common people become so acquainted with this science that forms the basis of our material life. This will necessarily be true due to the fact that there are more high-school students today with a knowledge of chemistry, rudimentary as it may be, than any other group that is being subjected to our educational process.

At the outset it should be understood that no ulterior motive whatsoever has prompted the author to prepare this article for publication. He has received recognizance in no way whatsoever, no credit in any educational institution, nor was the article prepared as a part of research work required for an advanced degree, or under the direction of any college instructor. It was on the contrary purely an interest in certain conditions under which chemistry is being taught in this State. The collection of data has at least been of interest if of no other value and the coöperation manifested by the teachers throughout the state has indeed been refreshing. If the information contained in the article, together with the conclusions the author has taken the liberty to draw, contributes in even the smallest degree to the efficiency of the present system, the author shall feel amply rewarded for his efforts.

Realizing that the only way to get the desired information with any degree of reliability would be to get in touch with the chemistry teachers themselves, the following questionnaire was mailed to them. It being impossible to get from the state department a list of high schools offering the subject, the process of selection was resorted to. The questionnaire was mailed to those schools listed in the State Directory as having chemistry courses and to all other schools deemed large enough to offer it or to schools where chemistry was known to be taught through the personal knowledge of the writer. The author is quite confident he missed but few public high schools that offer the subject in the state.

QUESTIONNAIRE TO CHEMISTRY TEACHERS OF IOWA

Name of Chemistry Teacher.

High School.	Enrolment.
Number of Years Chem. Has Been Taught?	Students in Chem. Dept.
What Chemistry Text Do You Use?	Laboratory Manual?
Is There a Lab. Fee Charged?	Breakage Fee?

Teaching of Chemistry Occupies What Percentage of Your Time?

Is Chemistry Elective or Required?

What Extra-Curricular Activities Are You Called Upon to Perform?

What Degree or Degrees Do You Hold?
Was Chemistry Your Major While in College? If Not What?
Have You Ever Done Any Graduate Work in Chemistry?
How Many Years Have You Taught Including the Present?
How Many Years Have You Taught Chemistry?
Did You Teach Chemistry in Your First Teaching Position?
In Your School Does Chemistry Appeal More Strongly to Boys or Girls?
What Phase of Chemistry Do You Find Most Difficult to Teach?
What Change Would You Suggest So That You Could Do a Better Job of Teaching Chemistry?
Do You Find That the Average High-School Student Does Not Know How to Study? Weakness?
What Problems Are You Confronted With in the Teaching of Chemistry?
Should Chemistry Be Offered as a Junior or Senior Subject?
Would You Like to Learn the Results of the Above Questionnaire?

General Conditions

Number of Schools Offering Chemistry.—In making a study of the general conditions let us examine the returned questionnaires. Of the 111 such questionnaires mailed out we find that 72 are returned. Of the number returned we find that 64 or 88.8% are offering the subject. One reason as to why few Iowa high schools offer the subject is due to the fact that almost invariably general science, physics, and biology must be introduced into the curriculum prior to that of chemistry. Then, too, due to the agricultural nature of the state there are few large city schools. Of the 928 high schools in the state there is little doubt but what chemistry is taught in only about 10% of them. The author is inclined to believe that the majority of high schools in the State that offer chemistry answered the questionnaire and that therefore the results will be fairly indicative of conditions over the entire State if complete returns were possible.

Student Enrolment in Chemistry Courses.—Let us for a moment compare the total enrolment of the schools represented with the total of those enrolled in chemistry courses. Here we have a condition that should be alarming but is nevertheless what the author predicted. Of the 34,190 high-school enrolment, only 3042 are taking courses in chemistry. This represents 8.9% of the total.

Number of Years Chemistry Has Been Taught.—In considering the question, "How many years has chemistry been taught?" a few were not in a position to give such information. The information received is tabulated below.

TABLE I

No. of years	No. schools reporting
1– 4	10
5– 9	10
10–19	16
20 and more	14
Not reporting	14

Chemistry has been taught in the Burlington schools more than 50 years.

Chemistry Textbooks in Use.—Three chemistry textbooks seemed most popular in Iowa. In regards to the manual in use the great majority of schools use the same author manual as the text. However, we have some getting away from this since twelve indicated a different manual from the textbook they were using.

Laboratory and Breakage Fees.—In studying the policy of the schools represented regarding fees the following table gives the information.

TABLE II

	Yes	No
Laboratory fee	9	55
Breakage fee	62	2

Most of the schools represented where a laboratory fee was charged were schools offering junior college chemistry. In regards to the amount of breakage fee charged it is a rule in most cases to merely charge for actual breakage although some have a flat fee. The amounts were usually between 50c and $1.50, although in eight cases it was $3.00 or more.

Teaching Load of Chemistry Teachers.—In answer to the question, "Chemistry occupies what percentage of your time?" the following tabulated data gives the results of the questionnaire in this respect.

TABLE III

Per cent	No. of schools
25 or less	16
26 to 50	29
51 to 99	7
100	12

Several of those who give all their time to the teaching of chemistry are teaching in high schools that also maintain a junior college.

How Chemistry Is Offered.—In answer to the question, "What extra-curricular activities are you called upon to perform?" we get a great variety of answers. Of the 64 teachers represented in this study only nine stated that they had no outside duties. As all the teachers represented but four are men we find many of them assisting in the coaching of athletics and many others are acting in administrative capacities. The following are expressions of some that are representative: Athletics, Student Council, Junior Class Sponsor, Class Advisor, Science Club, Asst. Athletics; Asst. Coach, Golf, Tennis, Advisor Hi-Y; High School Treasurer, Bus. Man. Student Publication; Miscellaneous; Coach J. C. Basketball, Prin. of H. S., Dean of Junior College; Coach Football, Class Sponsor; All Athletics. It no doubt would be hard to be a good chemistry teacher in addition to carrying some of the above duties.

Conclusions.—The author has taken the liberty to draw certain conclusions from the above data. In regard to the number of students taking chem-

istry the showing made is indeed regrettable. It should no doubt be taught to a much larger group than at present. It is interesting to note that there are very few high schools in the State having an enrolment of 350 or less that offer the subject and it might be mentioned that occasionally we find a large high school not offering the subject, Lincoln High School of Des Moines for example. This is one of our real problems, as I see it, to awaken an interest on the part of more of our pupils. The author is not in a position to state whether it should be required or not. But this much is certain, there are too many electives in our curriculum which, because of the ease with which they can be studied as compared with chemistry, cause them to be chosen in preference to chemistry. The American youth of today is not eager to acquire an education and it is therefore more essential that the teachers have something to do in making out the pupil's schedule rather than trust to luck and leave it entirely to the individual. The average high-school student gives but little thought in making out his schedule and what he does give is usually devoted to determining which will be the easiest courses. A student that has learned to study a chemistry lesson is indeed well prepared because of the development of the scientific mind to study most any lesson. Especially in the teaching of chemistry do we have the opportunity to impart systematic thinking and reasoning. The author is inclined to be somewhat optimistic however as to the future teaching of chemistry in our high schools. People on every hand are realizing more than ever before the value of a knowledge of chemistry. Judging from the inquiries I am receiving regarding the findings of this survey I am satisfied that the adoption of the subject in many of the smaller high schools of the state is being given serious consideration.

From Table II we can readily see that most schools offer the course without the need of a laboratory fee. However, in respect to a breakage fee it has been the experience of most schools that the student will keep the breakage to a minimum when he himself is required to pay for any broken pieces.

In studying the teaching load we find more teachers devoting one-quarter to one-half of their time to the subject than in any other group. Indeed it is to be considered fortunate to be in such a school that one can devote all his time to the subject.

In speaking of extra-curricular activities the chemistry teacher is called upon to perform it is well to remember that he must because of existing conditions do a certain amount of it. Nor would it be desirable that he be excused entirely from all extra-curricular activities. Just where to draw the line is the question. As much of his extra-curricular activities as possible should be related to his work. It is my belief that some of the extra-curricular activities, such as being a class sponsor, are valuable

opportunities to interest students in taking the subject and thereby help solve our great problem of interest.

Training and Experience

The training received by the chemistry instructors of the state is a valuable thing to consider. All chemistry teachers to my knowledge possess a four-year degree from some college or university. The variety of degrees held by our chemistry teachers is quite broad. The frequency is as follows, B.S.—26, B.A.—26, M.S.—7, M.A.—5. Only the highest degree held by the individual was listed. Most of the Masters were instructors that are required to do some teaching in junior college in addition to their high-school courses.

Number of Teachers Majoring in Chemistry.—The following table shows the results of the question, "Was chemistry your major while in college?"

TABLE IV

Chem. Major	Rel. Science	English	History
46	11	3	4

Teachers Taking Graduate Work.—The question, "Have you done any graduate work in chemistry?" should be of interest when we wish to consider the professional spirit of our chemistry teachers. Chemistry is a growing subject and it is necessary to do some graduate work from time to time if we are to keep abreast of the times. The following sums up the results of the question. Out of 64 teachers reporting, 40 have done graduate work in excess of 12 semester hours while 24 have done no graduate work.

Teaching Experience.—Perhaps the most important factor in the training of a successful teacher after graduation from college is the number of years experience. The following table gives the respective data:

TABLE V

Yrs. experience	No. teachers	Per cent
1– 2	5	7.8
3– 5	20	31.2
6–10	30	46.9
More than 10	9	14.1

Chemistry Teaching Experience.—In studying the question, "How many years have you taught chemistry?" we may look at the tabulated data in Table VI.

TABLE VI

Yrs. taught chem.	No. of teachers	Per cent
1– 2	16	25.0
3– 5	22	34.4
6–10	20	31.2
Over 10	6	9.4

In answer to the question, "Did you teach chemistry in your first teaching position?" the results might be summed up in the following sentence. Out of the 64 teachers reporting 36 did not teach chemistry in their first teaching position while 28 did.

Conclusions.—It is the author's belief that the teachers of the state make a very creditable showing in the matter of training. With all of those reporting possessing degrees and the majority having done graduate work, they are indeed well prepared, perhaps better prepared than the average high-school teacher of other subjects in Iowa.

The showing made by the chemistry teachers of the state is very good in regard to their training as preparing them to teach chemistry. About two-thirds of the teachers reporting have majored in chemistry while at college. This showing should speak well for any State. It is to be remembered, however, that only the larger high schools offer the subject and the larger high schools are somewhat more exacting as to the credentials a teacher possesses in securing a position with them. The author is of the opinion that there are few misfits teaching chemistry in the State. The great majority because of their graduate work and their training are naturally cut out to be teachers. Few will ever enter other professions.

In regard to experience we find that about 61% of the teachers have taught six years or more. The last few years have found the teachers remaining in their positions more so than formerly. Most of the teachers represented in the questionnaire have been in their present positions from 2 to 4 years prior to this year.

Most of the chemistry teachers now teaching did not teach chemistry in their first teaching position. This is to be expected since so many schools do not offer the subject. However, the chemistry teacher can in a year or two be teaching the subject in the same school system through bringing pressure to bear in regard to adopting it, or secure another position in a larger school where he can teach his major subject.

Problems

Difficulty in Presenting Subject Matter.—It is always of interest to chemistry teachers to know what phase of the subject to put greater emphasis on. In answer to the question, "What phase of chemistry do you find most difficult to teach?" the following answers are typical. Theory, Ionization, Problems; Theory, Atomic weights, Use of equations in quantitative calculations; Balancing equations; Valence, Periodic Law, Atomic and Molecular weights; Chemical mathematics, especially that of equations; Problems. Students can memorize principles but fail to apply them; Ionization, if any; one wrote "All parts alike." Another wrote "No difference as long as it is chemistry," and then we have the

person that answers thus, "Acids, Bases & Salts." The great majority find that problems and equations are the sources of most of our trouble.

Improving Teaching Methods.—In asking the question, "What change would you suggest whereby you could do a better job of teaching chemistry?" I was trying to find out just what changes might be made that our teaching might be more effective. We find about as many answers as teachers represented. Following are some typical answers.

Lack of time and equipment for sufficient laboratory work.
Better training in fundamentals of arithmetic. Proportions. Decimals.
Make third semester algebra a prerequisite.
Better textbook.
Fewer classes. More equipment. Better reference works.
Have general science required with competent teachers.
Make course more independent of college chemistry.
More pandemic nature since few go to college.
Supervised study.
Possibly more illustrative material.
More time in arranging demonstration apparatus.
Less consideration to college preparation,
New laboratory on ground floor. Fumes bad on top floor.
Elimination of still more topics. Revision of theory work for high schools.
Smaller classes. Better preparation in arithmetic.
Have a full-time assistant.

In looking over some of the above answers we find that many can be corrected as soon as money is available for improvements. In some schools, because of system-owned textbooks, it is very hard to change to a later text. Having a full-time assistant no doubt would solve many ailments but, alas, this is almost too good to be true.

Lack of Proper Study Habits.—There appears to be little doubt in the minds of the teachers as to whether a high-school student knows how to study, especially a science such as chemistry. The question, "Do you find that the average high-school student does not know how to study?" was answered by 60 of the 64 in the affirmative, while the other answers were; possibly, about 50%, about 25%, and that is what we are here for. The last answer is no doubt true to a certain extent but it should be borne in mind that we need the hearty coöperation of every one in helping to correct this situation. In our endeavor to determine some of the weaknesses the following will suffice.

Inability to organize and concentrate.
Skim reading. Lack of interest. Inattention. No life purpose.
Never have been taught or required to study.
Considers hasty reading sufficient.
Cannot think ahead. Too much memory work.
Inability to pick important items and then retain them.
Ability to distinguish between essentials and non-essentials.

Like to kid around too much.
Ability to reason from one fact to another.
Lack of concentration and budgeting of time.
Failure to give proper weight to important parts.
Laziness. Outside work. Athletics.
He is supposed to study what he is doing and not just *do experiments*.
Pupils do not seem to be able to study properly. It seems to me no science offers a better chance to show the pupils how to study than does chemistry. This is one of the things we aim to do.

Problems in Teaching Chemistry.—The question, "What problems are you confronted with in the teaching of chemistry?" should be of value to the teacher to consider. The following is a partial list.

Finding time to help weaker students. No satisfactory method of distinguishing between work to be assigned to an *A* student and work to be assigned to a *D* student.
Correcting study habits. Getting coöperation of weaker students. Lack ability to think out simplest problems.
Keeping the slow ones up with those of most ability.
To teach more chemistry to a junior college class than I do to my high-school classes without lowering my high-school standards.
To make general theory interesting. To make it practical without sacrificing general principles, to make it practical without hurting those that go on to college.
Making work sufficiently attractive to compete with more popular subjects such as English, History, Manual Training, etc.
Lack of initiative. Reasoning power. Laboratory work too mechanical.
Not being able to relate in chemical form what they do in laboratory.
Lack of laboratory time. Mathematical phase.
Support. Lack of intelligent aid. Theft and cribbing by pupils.
Making situations concrete. To convince them that the theoretical is true.
Lack of sufficient laboratory space. School-owned texts. Cannot change.
Unwillingness on part of pupils to give continuous effort in preparation, if more time is needed in any lesson. Mental laziness.
The teaching of the scientific method. Creating an interest and a desire for understanding. Student self-reliance.
Correlating laboratory work with class work.
Lack of laboratory space. Two pupils must work together.
Solving problems at ends of chapters. Getting students to do precise work.
Chemistry is harder than the average high-school subject yet they expect the same grade for no more work.
A foundation in arithmetic plus an ability to read understandingly are our big problems.

One chemistry teacher writes. "I have more serious problems in the junior college chemistry than I do in the high-school chemistry." The same person writes concerning projects, "Projects create interest and therefore better and closer application in studying the subject. However they do not teach much chemistry. Therefore too much stress should not be placed on projects other than creating interest." He also asks the question, "What do you think of organizing a course of such standard in chemistry as to demand college credit? One year high school being

equivalent to a half year college work or thereabouts?" The author might state that this has been done for a number of years at the University at Iowa City. The students take an examination and if successful they start qualitative analysis receiving in advance one half year college chemistry credit. The idea no doubt is all right for who can deny that there is a great overlapping of subject matter in high-school and college chemistry?

Junior or Senior Subject.—Some may be interested in the consensus of opinion in whether the subject should be offered primarily to juniors or seniors. Of the teachers reporting 34 were of the opinion that it should be a senior subject, 16 thought it should be a junior subject, and 14 thought it should be offered to both equally. Some think that physics, because it applies more to what the student already knows, should be considered the easier. Another thinks that more going to college will take chemistry and hence should have it in his senior year in order to retain more of it.

Conclusions.—There seems to be nothing wrong with the training and experience of our chemistry teachers throughout the state. Our teaching methods, whatever they may be, will stand a little revamping. There is an open acknowledgement that we are not very effective in the teaching of the subject. Getting more students interested in the course is one of our biggest tasks. We can't sit back and be indifferent and expect the students to roll in because they won't. As one teacher has stated, "I should like to have some way of advertising the course to the rest of the student body. Are there any plays for this purpose?" No doubt the choice of such plays is limited. Subscription to a small chemistry publication will prove helpful in stimulating interest. Also the writing of news items for the school publications is always a good way to advertise.

Most of our college professors despise pedagogical training. This means that they are to do little as far as the teaching of chemistry goes. This opens up an uncrowded field to the high-school chemistry instructor. Of course, it is to be understood that the high-school teacher needs to do more teaching research than the college teacher. He can't fail his students right and left without coming in contact with very undesirable criticism and he must impart sufficient chemical knowledge so they can go out and do routine chemical work or pursue advanced college work, as the case may be, to the credit of the school.

Chemistry teachers will do well to remember that their value to the community will not be determined by their qualifications alone but rather by how much chemistry they can impart to those under them.

Thoroughness plus enthusiasm equals success. Try it.—H. A. HOLMES

AIMS VERSUS METHODS IN CHEMISTRY

FREDERICK REED, McGUFFEY SCHOOLS, MIAMI UNIVERSITY, OXFORD, OHIO

There is an encouraging unanimity among science teachers (the communicative ones) as to the essential objectives of chemistry instruction in the secondary schools. "The scientific attitude" usually occupies the place of honor at the head of the list, followed by "an appreciation of the rôle of chemistry in modern life," "the fundamental principles necessary for advanced study," and "practical information for every-day living." There should be no carping at so laudable a program; providing, of course, that it is not only laudable, but practicable.

The most ambitious of these objectives, and the most elusive, is undoubtedly the first. Nothing but the blandest optimism can conceal the fact that there is little in the content of a chemistry course to create or even encourage the scientific attitude, with all which that term implies. We may hope, trust, and pray that in the long run and on the whole this living spirit will rise like the phoenix from the dead ashes of factual content, but we must confess that our faith is "the evidence of things not seen."

Perhaps it is better to face at the outset the possibility that this scientific spirit may after all be only the ghost that the term implies—or a verbalism too intangible to grasp. Or it may be too distant a star to be harnessed to the creaky wagons of a variegated mob of adolescent youngsters. If so, let us be frank about it—among ourselves, at any rate.

If, on the other hand, the scientific attitude consists in definite habits of thought and technic, it is possible there may be found in teaching methods the encouragement that subject matter cannot give one. There follows an account of a procedure now being worked out in a chemistry class in the McGuffey training schools, Miami University, definitely aimed at this tantalizing target.

No textbook or laboratory manual is employed during the first semester, and there are no assignments for outside study. During the first few days of school the notions possessed by the class on the composition of matter are drawn out, discussed, and the concept of elementary substances developed. A list is made of those elements the class already knows and a few important ones are added to it. Drill work is given on correct spelling and on symbols. It has been found possible also to give a class a working knowledge of atomic weights and of chemical problems involving weight relations during the first week, but this is not the usual practice.

With this preliminary preparation, the teacher is ready to start the class toward his first goal—the comprehension of chemical activity. It makes little difference what specific topic one starts with, but the class discussion must begin with the pupil's experience and develop some problem which can be attacked in the laboratory. It may be noted, digressively, that in the

perennial discussion of the question whether laboratory work is really more effective than a lecture-table demonstration, little is said about any other aim than the acquisition of facts, and the only distinction made between the two methods is whether the performance should be the pupil's or the instructor's. It is questionable that a genuine *experiment* can ever be performed vicariously.

The topic of combustion is, of course, a convenient and conventional spring-board into the general question of chemical reactions. The unprepared class is first quizzed on its general knowledge of burning, starting with some such question as "What is the best way of kindling a campfire? Why? Why? Why?" No question ever devised is a more powerful stimulus toward mental activity than that innocent monosyllable.

The source of all information offered is carefully scrutinized, and that which is founded upon direct observation and unanimously accepted by the class is concisely outlined on the board, *viz.*,

- Burning
  - Requires
    - A combustible substance
    - Air
    - A kindling temperature
  - Results in
    - Heat and light
    - "Smoke"
    - Ashes
  - Its rapidity depends on
    - Fineness of combustible material (ratio of surface to volume)
    - Temperature
    - "Draft"

A truly remarkable portion of the general information found in textbooks is already in the possession of at least part of the pupils, and needs only organization to become "science." Incidental to some such development as this appear disputed points and unanswered questions, and these too should be recorded:

- Why are some substances incombustible?
- What fraction of the air is needed?
- What constitutes "smoke?"
- What is the composition of the ash?
- Why does increasing the surface increase the velocity?

The function of the recitation is two-fold: to organize information and to develop problems, and the second is not the less vital. Some of the items in this list are casual queries, and some are, or may become, genuine problems. A question becomes a problem only when a sincere desire exists to find the answer—as when it is a point of controversy, or naturally puzzling.

It is here that the necessity for the rather drastic action in banishing the text becomes apparent. Up to this point, the procedure has been the simple application of the problem method, as employed in making the assignment in any subject. In such cases, the next step consists in the teacher's announcing the book and page to be studied to learn the answers. But in so far as the scientific attitude is our goal, appeal to authority must be avoided, as fatal to the spirit of inquiry which motivates discovery.

It is far from necessary or desirable that all the questions which arise and are listed during a class discussion should be answered then or any other time, providing that the pupils are clearly aware of what they do not know. The column in their notebooks headed "Things We Know" should always be out-measured by the one under "Things to Find Out," to stimulate curiosity and to discourage opinionated dogmatism. But any question that is adapted to laboratory investigation is chosen for further consideration. For example:

"How can we find out whether a burning substance consumes all of the air that is available?" So general a question is largely rhetorical, and needs to be broken up for the class to attack with confidence. So, after a pause, "What will we need?"

"A candle, or something to burn; air, and something to contain it."

"How can we tell when air has been removed from the container? Is there anything which can replace it?"

The manner of questioning is of considerable importance. The teacher is not endeavoring to lead the pupils to a fixed, predetermined conclusion, and his attitude should indicate it. Suggestions that are original and practical not infrequently come from students of mediocre ability. The answers to these questions are not either "right" or "wrong," but are carefully weighed as to relevancy, practicability, and completeness. If the class exhausts itself before arriving at a method which can be put into practice, the teacher may volunteer needed information; directions are not given except when some final caution is necessary for the safety of the experimenter and the apparatus. In this way, the class and the teacher working together arrive at the decision to burn some inflammable material in a closed flask having an outlet which is under water. The details of the technic remain to be devised, and it may either be left to the individual student or developed in class discussion as to how the burning material shall be supported and the volume of the displaced air measured. What is really important is that the pupil should go to the laboratory with a problem in his mind and a general idea of how to arrange an experiment to answer it. When a laboratory manual is used as a guide, the performance of the experiment becomes an end in itself, and the directions given are followed because they are in the book, and not because they will answer a question.

The laboratory notes are recorded under these heads:

1—What I wanted to find out
2—What I did
3—What I observed
4—What I conclude from my observations.

These notes form the basis for the following recitation-discussion, in which pupils report on their procedure, their observations, and defend their conclusions. Considerable interest is taken in comparing technics, and there are some disputes about observations, but the most fascinating part of the whole plan consists in drawing legitimate inferences which will account for the observations. Here again the teacher acts only as scribe and umpire, and sometimes as adversary. In the course of the debate new questions arise: "What are the sources of error which cause varying results?" "Why are most of them too high?" "Does the amount of air consumed depend on the nature of the burning material?" "What suggestions can be made for improving the technic?" And finally the class goes back to the laboratory to test these suggestions, to eliminate errors, and justify results. Gradually, the importance and significance of repetition and duplication of results, controlling variables and running blanks, positive and negative results, are impressed upon the pupils through their own experience.

And in the meantime, while the scientific attitude is being striven for in school hours, the time formerly devoted to outside study of a textbook is dedicated to another aim: an appreciation of the part chemistry plays in present-day civilization. At the first of the year the pupils buy the sets of books offered by the Chemical Foundation for general reading: "Creative Chemistry," "Discovery," "Pasteur," "Medicine in the Age of Chemistry," and "The Riddle of the Rhine." Many pupils prefer to have all five volumes, but it is permitted that two may share a set. Here again, no definite assignments are made save the requirement of a brief written report on fifty pages each week, to be taken from any volume which interests them, or from other sources as well. At the end of the semester a theme is required on one of the American Chemical Society prize essay topics, and most of the reading is directed toward the topic chosen. The fact that all promising essays will be submitted in the contests helps to motivate this part of the procedure.

It may perhaps be concluded at this point in the recital that everything is being aimed at except a knowledge of chemistry. It is true that there is time lost; fewer topics are covered, and fewer experiments are performed (It will be understood that exercises taken from a manual are called experiments only by courtesy.) Certain members of the class, who are good students when a textbook is at hand, fall behind. Nevertheless, funda-

mental principles are arrived at, and a considerable volume of chemical facts learned, tied together, and, most important of all, based upon first-hand experiences.

But the second semester the procedure is greatly changed, and it becomes the aim of the class to measure up to the standards set for a high-school course. The pupils are given the list of minimum requirements as outlined by the A. C. S. committee, a textbook is recommended (although all students need not use the same one) and the recitation period is largely used for quizzes, drill, and supervised study. Some time is given to devising laboratory experiments and discussing their difficulties, but laboratory work is now largely individual. Direct instruction is offered only in response to a demand from the class. The work is organized about the general principles based upon laboratory experience and developed in general discussions; such concepts as the kinetic and ionic theories and the electronic constitution of the atom, having been accepted tentatively as plausible explanations of chemical behavior, are employed as a framework to unify the whole course.

Whole-hearted approval and general adoption of the innovations briefly outlined in these pages is neither to be expected nor desired. The scheme is wholly on sufferance, as all methods should never cease to be, and its defects are to be tolerated only until inspiration or experience suggests their cure.

Stealing Marks. The president of one of the great western state universities, addressing the Inland Empire Education Association, declared according to the Associated Press reports for April 10th that sixty per cent of our college students are willing to steal their grades. There is further food for thought in the facts reported in the last *Kadelpian Review* about honor systems, that at Yale, Amherst, Western Reserve, Rutgers, Washington and Lee, and other of our larger colleges have abandoned the honor system because the students themselves were dissatisfied with it. "Loyalty to the group is stronger in most instances than allegiance to abstract standards of behavior. This is all the more so when we know that students often do not consider cribbing a serious moral lapse, but merely a device for getting ahead of the teacher."

If students cheat in college, it is because their previous experience has shown that cheating is profitable, *i. e.*, that there is more to be gained by cheating than by not cheating. Human impulses run deeper than man-made codes. Honesty will be the best policy only when we make it so. We cannot afford to send our pupils from high school with the thought—"Is there a speed cop on this road?"—and with no thought that it is wrong to drive eighty miles an hour in reasonably heavy traffic—only wrong in case they are so unfortunate as to be caught. This situation seems now to apply in so far as cribbing is concerned. It is a situation which we must combat in the elementary school, in the high school, and in the college. Foul playing in sports is penalized quickly, not only by the referee but by the crowd as well. There seems to be no reason why we cannot attain the same social attitude toward the student who cheats in his academic work.—*High-Sch. Teacher*, **5**, 192–3 (June, 1929).

SUPERVISED STUDY IN GENERAL CHEMISTRY

A. T. BAWDEN AND F. A. JACKSON, BAYLOR COLLEGE FOR WOMEN, BELTON, TEXAS

General chemistry has a reputation throughout the United States for its difficulty. In this course, failures are frequent and not unexpected. It is recognized that general chemistry cannot be mastered without spending more time in study than students often allow. In our experience, the majority of failures in this subject may be attributed to a lack of study and inefficient study methods. In the majority of schools nothing is done to alleviate this situation.

Over a year ago we decided to change general chemistry texts. We finally chose a recent text in which the experiments and text have been built into one, and in outlining the course based on this new text we found that we were almost forced to adopt the supervised study method of teaching. The need for a better method, the knowledge concerning it, and the desire for it, led to this method only when a text adapted to it was found. We desire to give due credit to the text which made possible our success with the supervised study plan as outlined in this article.

Results Obtained from Former Method

Table I shows the final examination and course grades made in general chemistry, using one of the most popular standard texts. This course was handled in the usual way. Three one-hour lecture-recitation periods and two three-hour laboratory periods were given each week. Daily ten-minute quizzes and three one-hour examinations (the last one being the final examination) were given each term. Problems and questions at the end of each chapter were worked out at home and handed in. The class periods were used for recitations, lectures and lecture demonstrations, drill,

TABLE I

RESULTS WITH FORMER METHOD

Course number	No. of students	Date	Average examination grade	Average course grade	Number of failures	Per cent of failures
101	33	Fall 1926–1927	67.8	78.9	6	18.2
102	22	Winter 1926–1927	58	78	5	22.7
101	19	Winter 1926–1927	51	76.6	3	15.8
102	18	Spring 1926–1927	37.7	68.3	7	38.9
		Summary				
101–102	92	1926–1927	59.2	76.8	21	22.8

Average 102 examination grade: 48.9

and board work. The laboratory work consisted of the usual experiments during the first term, and elementary qualitative analysis during the greater portion of the second term. Great difficulty was experienced in correlating the laboratory work with the class work and for the most part the attempt met with failure.

The foregoing tables were compiled using only the grades of those students who completed Chemistry 101 (the first term of general chemistry) or Chemistry 102 (the second term of general chemistry). Fewer students have dropped general chemistry before completing one or both terms' work under the new plan than under the former plan.

Results Obtained from Supervised Study Method

Table II shows the final examination and course grades made in general chemistry under the supervised study plan.

A comparison of these tables shows that the percentage of failures dropped from 22.8% to 1.0%, while the average course grade rose from 76.8 to 83.2 under the new method.

It might be argued that with a new grading system, higher grades might be given. The above results were proved to be indicative of the true nature of affairs by the following check. For the final examination, the classes in courses 102 under the supervised study plan were given exactly the same questions that were used for the same courses under the usual plan. In spite of the fact that this examination was based on the former text, the students taught under the new plan made a higher average grade than had been made by the students in the classes taught by the old plan. These grades rose from 48.9 to 67.8. This examination was a rather thorough test of general chemistry, which fact accounts for the low grades.

TABLE II

RESULTS WITH SUPERVISED STUDY

Course number	Number of students	Date	Average examination grade	Average course grade	Number of failures	Per cent of failures
101	36	Winter 1927–1928	74.6	87.2	1	2.8
102	31	Spring 1927–1928	65.7	80.6	0	0
101	16	Summer 1928	71.5	81.3	0	0
102	18	Summer 1928	71.6	81.2	0	0
		Summary				
101–102	101	1927–1928	70.9	83.2	1	1.0

Average 102 examination grade: 67.8

This experiment in teaching methods lacks conclusiveness in the following respect. The students who took general chemistry in 1926–1927 had not had a course in pandemic chemistry, though many of them offered entrance credits in high-school chemistry. On the other hand, the students who took general chemistry in 1927–1928, had either previously studied chemistry in high school, or had passed one term's work in pandemic chemistry. It is probable that this appreciation course was responsible, in part, for the better showing in the supervised study plan. We believe that it was wholly responsible but realize that we have not proved it. We are submitting our results with the hope that they may be suggestive, if not conclusive.

The Supervised Study Plan in Detail

The students were asked to arrange their schedules so that they could spend three hours each day at the chemistry department. This plan incurred little difficulty in arranging schedules, since it merely called for two extra hours three times a week which the old method did not require. This extra time was the equivalent to that formerly expected to be used at home in study. In a few cases, this much time was not used by the students; but in many cases we know that students averaged much more than two hours in preparation of their work at home. The students have been unanimously enthusiastic about the new plan, for they leave the chemistry department with their work completed. Our experience leads us to believe that the new plan yields better results in less time than required by the old method.

The laboratory work is so closely woven into the text that any other plan than the one adopted would be difficult to manage. Perfect correlation is possible in the supervised study method, for the students go into the laboratory and perform the experiments just as they come to them in the text. The writers believe that the author's plan of building the experiments into the text is superior to that of the usual laboratory manual which is seldom used so that it may correlate with the class work.

The course was carefully outlined and each student was provided with a booklet of information containing the daily assignments. An extract from this booklet will serve to show in more detail how the plan works out.

> The student will use each period for study, laboratory, review, and quiz work as the occasion demands.
>
> At the close of the second week, the class will be divided into two sections. There will be a star section, to which only students falling in the upper 50% will be eligible. This section should require less time to do its work than the other section. It is recognized that students should be sectioned according to ability or accomplishment. If possible the star section will meet from two to four o'clock every afternoon, while the second section will meet from two to five o'clock.
>
> A teacher will be present all of the time to supervise the laboratory work and the study. Questions will be answered as you do your studying, but it must be pointed

out that such questions must never be substituted for real work on the part of the student.

It is important that the laboratory work should be carried on with as little commotion as possible. While one student is working on an experiment, another may be studying her textbook. The same conditions should exist in the laboratory as in a study hall. For that reason no talking or visiting will be permitted. Each experiment must be carried out by each student independently of the other students. Do not be concerned about the results of other students. The teacher will be present to aid and advise you, and all aid and advice should come from the teacher.

A written quiz covering the day's work will be given at the close of each two- or three-hour period as the case may be. More comprehensive examinations will be given at the close of each week's work.

Any student who fails to make a passing grade in an experiment must repeat it. Any student who fails to make a passing grade in the weekly examination will not be allowed to come to class again until she succeeds in making a passing grade in another special examination. The purpose of this plan is to see that the student does not get behind. If a student does get behind she cannot pass the course, and should therefore drop it. There should be no failures in this course. No one should be required to drop the course for our plan provides that each student shall put in the time necessary.

Two things only will cause disaster. The first is absences. No student can afford to be absent even one time. All absences must be made up as soon as possible in extra periods for the welfare of the student. Since make-up periods will take extra time for the instructor, a charge of 10 cents an hour (payable at the time of the extra period) will be necessary to help to pay for this extra time, and to discourage unnecessary absences. This charge will be doubled for unexcused absences. The other thing that might result in disaster is improper use of the time while in the laboratory and classroom. As far as possible, the teacher will try to check any tendency in this direction.

The following grading system has been found satisfactory:

Daily quizzes	$^4/_{10}$
Weekly examinations	$^3/_{10}$
Final examinations	$^1/_{10}$
Notebooks	$^2/_{10}$

All laboratory experiments are checked as soon as they have been performed and written up.

The results here reported were obtained while using the text designed for students who have not had high-school chemistry. This year we have adopted the same author's text for students who have had high-school chemistry, with very satisfactory results as far as we can tell at the time of writing. This new text was adopted because it omitted the material of the minimum required high-school course of the American Chemical Society. It was not until this year that our course in pandemic chemistry was sufficiently developed to make possible the use of this text. Beginning with this year, however, we have rigidly required all students who have not had a satisfactory chemistry course in high school to take one term's work in pandemic chemistry before entering general chemistry. We be-

lieve that an appreciation course must precede general chemistry when taught by the supervised study plan, for many of the usual lectures designed to give this appreciation are necessarily omitted in the supervised study plan. This appreciation course should cover the above-mentioned minimum requirements for a high-school chemistry course.

The teacher does not just sit at a desk and "preside over the meeting" in this plan, but he is kept busy every minute, correcting laboratory technic, checking experiments, answering questions, and guiding students in their study. Frequently, it is necessary to give explanations or directions to the class as a group, but no formal lectures are used. Many of the students have no idea how to study and much time is spent in the first few weeks teaching them how to study chemistry, by the use of outlines and other methods which the teacher has found to be successful.

The Two Methods Compared

The supervised study plan requires more time for the teacher than does the usual method. For that reason, it would not appeal to the teacher hired to teach because of his research ability, who feels that "teaching would be a great profession if it were not for the students." The teacher who is accustomed to visiting his class three times a week for a lecture, turning over all the rest of the work, including laboratory supervision, to inadequately trained assistants would also find his private time heavily eaten into by this new plan. On the other hand, teachers who really enjoy teaching will welcome this opportunity to help students when they need help most. They will find, as we have found, that it is a new experience to be regarded as a helpful friend rather than a detective or a phonograph record. Pandemic chemistry necessarily requires the lecture method of presentation, but we have yet to see a general chemistry student's notes taken from lectures which were equal to general chemistry texts now in print. It is our belief that the content of a general chemistry course has been too well standardized to leave any excuse for the lecture method. The supervised study plan saves a great deal of time in presentation, for it leaves out useless lectures and recitations, and answers the students' questions, meeting their difficulties at the exact time they occur.

Charles B. Fahs,[1] a student at Northwestern, expresses some of the objections which the supervised study plan overcomes as follows:

> Not only do I have to learn what the professor wants me to, when he wants me to, and in the way he wants me to, but I must also prove to him that I have done so. I must go to class to recite the lesson; I must prepare for and write examinations, and I must prepare themes and term reports. It is not sufficient that I have studied a subject; I must spend an almost equal amount of time telling the results to a professor who knows them already. In this way I must waste much time which I could otherwise

[1] *The Intercollegian*, **130** (1929).

spend in continuing my education.... The time spent in ascertaining how much the student has learned often exceeds that spent in helping him learn more.... You cannot have intellectual fellowship when one party is trying to cram education down the neck of the other.

Summary

A supervised study plan for teaching general chemistry has been described. Data have been given which show that this method is probably superior to the usual method in that less failures result, and the whole class gains a better knowledge of the subject in less time.

Tropic Sunlight as Treatment for Tuberculosis Investigated. Whether tropical sunlight is more effective in treating tuberculosis than the sunlight of northern climates will be investigated by scientists under the auspices of the Light Research Committee of the American Sanatorium Tuberculosis Association, it has been announced by Dr. Edgar Mayer, chairman of the committee. Dr. Mayer has just returned from the West Indies, where he has made arrangements for sunlight investigations with physicians in Porto Rico, Jamaica, and Trinidad.

Groups of physicists, chemists, and clinicians are being organized at various points in the United States and other countries, and these will conduct studies of sunlight for a period of about two years, Dr. Mayer stated.

"We expect to measure the spectral limits of sunlight in various climates, and to determine what spectral bands are best suited for the treatment of tuberculosis," he explained. "Animal experimentation will take the form of developing localized forms of the disease in test animals, and observing the action of sunlight.

"Our studies may also result in combating more successfully tuberculosis which is prevalent in the West Indies, in spite of abundant sunlight. The negroes of the islands, who suffer from it particularly, call the malady 'repentance disease,' because it often kills them in about two months, and they consider they are allowed about that time in which to repent for their sins.

"They appear to be particularly susceptible because of a diet which lacks vitamins. Moreover, many of the negroes work only two or three days a week and keep out of the sunlight as much as possible. They fear fresh air more than they do disease and often sleep seven or eight in a room, even plugging the keyhole at night to keep out the night air."

The tuberculosis death rate in many cities of the West Indies, Dr. Mayer said, was five times what it is in New York.—*Science Service*

Gold and Silver Plates "Photograph" Slow Electrons. The use of plates of gold, silver, copper, and zinc to record slowly moving electrons, instead of the usual photographic plates, was described at the recent meeting of the American Physical Society. Dr. Percy H. Carr, of Cornell University, told the physicists that when these electrons moving at what are even slow speeds, for them, strike the surface of some metals, they leave their mark. This effect is evident when the metal is exposed to certain metals. In studying the way in which electrons are bent in a magnetic field, Dr. Carr aimed them at a sheet of gold, for instance. Afterward, the gold was held over hot mercury, and the vapor combined with the gold in the places that had not been struck by electrons. The lines then appeared dark against a gray background. Other metals were used. For these slow electrons the method is superior to photographic plates.—*Science Service*

THE USE OF DRAWINGS FOR STIMULATING INTEREST IN LABORATORY TECHNIC

FRED F. DIWOKY AND JOHN R. LEWIS, UNIVERSITY OF WISCONSIN, MADISON, WISCONSIN

The men in charge of general chemistry at the University of Wisconsin[1] have long stressed the importance of laboratory technic. One rule that has been rigidly enforced for the past several years requires that any special apparatus built by the student must be approved by an instructor before the experiment may be performed. As a result, instructors cannot walk casually through the laboratory without "passing judgment" on the apparatus being used.

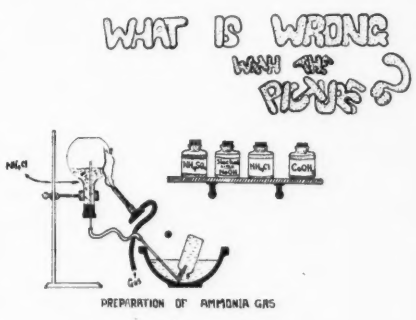


FIGURE 1

The authors felt that it should be possible to find a way of stimulating students' interest in laboratory technic so they, too, would be more critical of their own work and the work of others. With this idea in mind, a number of drawings, illustrating incorrect set-ups, were made and posted (one each week) on the general chemistry bulletin board. In some cases an attempt was made to include all the glaring mistakes that had been made by students as we had observed them. In others, less obvious mistakes were shown. Figure 4 showing the distillation of the alcohol-water mixture belongs to the first group while Figure 5 illus-

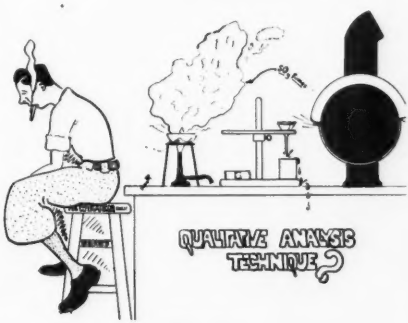


FIGURE 2

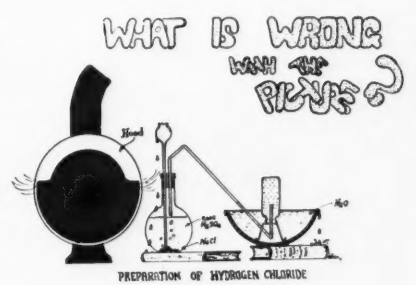


FIGURE 3

[1] Prof. J. H. Walton and Prof. F. C. Krauskopf.

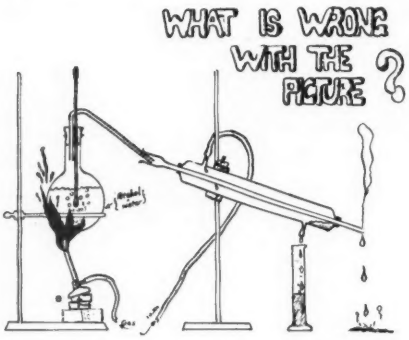


FIGURE 4

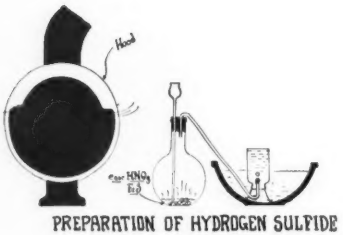
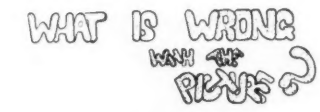


FIGURE 5



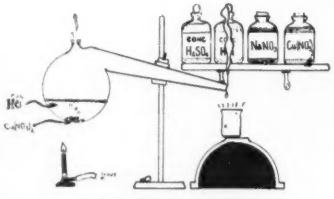


FIGURE 6

trating the preparation of hydrogen sulfide belongs to the latter group. A few representative drawings are reproduced here for purposes of illustration.

Discussion

The authors believe that interest has been stimulated in laboratory technic by these drawings. This belief is based on the fact that they were examined by practically every student enrolled in the course. It was not uncommon to see six or eight students congregated about the bulletin board, discussing the correct and incorrect features of the latest drawing posted.

It was interesting to note that older students, including graduates, also enjoyed them. The authors plan to add some drawings which will be of special interest to these advanced students.

Teachers who may wish photographic copies of these drawings should communicate with the authors.

Similar pictures prepared by Prof. John J. Compton of William Nottingham High School, Syracuse, New York, are to form the basis for a student contest to be conducted by the Chemistry Student section of THIS JOURNAL during the coming scholastic year. The first will appear in the October number.

A METHOD OF CHEMICAL INSTRUCTION

J. A. SOUTHERN, BOYDEN HIGH SCHOOL, SALISBURY, NORTH CAROLINA

In connection with our classes in chemistry this year a plan has been carried out which has been both interesting and instructive in its results. The first idea of the plan came to the instructor last fall when one of the students asked, "Why can't we see everything we study about?" The project consisted of preparing: displays of chemical compounds with their preparation, properties and uses, with special emphasis on their uses; charts of the common elements with their valences; and charts of radicals with their valences.

The objects in carrying out the project were: (1) to help the student to better understand chemical processes and reactions, (2) to develop the interest of students taking chemistry in the subject so that they may desire to pursue it further in higher institutions, (3) to arouse an interest in the students of lower grades in the subject so that they may have a desire to study chemistry when it is offered them, and (4) to develop a spirit of appreciation, in the students, of the relation of chemistry to their every-day life, of the contribution of chemistry to the scientific age in which we live, and of the opportunities that living in this scientific age involves. Special emphasis has been placed on the uses of chemicals on account of the last purpose.

All the work has been done by the students after school, under the supervision of the instructor. A small storeroom in the laboratory was used as a workshop. At the outset the big problem was the collection of materials. Of course most of the chemicals could be secured from the storeroom, but chemicals and reagents alone did not furnish the desired amount of material so the students wrote letters to manufacturing concerns asking for samples of raw materials and finished products. Much material was obtained in this way. The preparation, properties, and uses of the materials mounted were obtained by the pupils from reference books in the library. The students took much interest in looking for these facts, an interest which otherwise they might not have had; this gave the pupils knowledge which they would not have secured otherwise. There was quite a bit of competition between the students as a prize was offered for the best project. This had a tendency to make the displays neat and attractive as well as instructive.

The projects have been much used during the regular recitation period. For instance, one boy made a display of salt and its products. Starting with the common salt he showed the important products which are derived directly and indirectly from this compound. When sodium and its compounds were studied during class periods this particular display was used very effectively. The preparation of sodium by the electrolysis of fused

sodium chloride and reactions between various compounds and sodium producing sodium compounds were better understood by use of this display.

Many other displays of a similar nature to the one mentioned above have been and are being used. For instance, a project of potassium compounds was devised in which one student made several of these compounds out of wood ashes. By leaching the ashes the potassium salts were taken out and from the resulting liquid several compounds were actually made and purified. This particular project was very interesting from the instructor's as well as the students' point of view.

The rubber exhibit was quite attractive and instructive. A local tire company furnished most of the materials for this exhibit. Starting with the smoked para and displaying the other materials and ingredients, stages in the manufacture of automobile tires were shown. Different grades of cord, with and without the rubber, used for different parts of the tire, results of vulcanization, and tread work were some other phases projected. Though the actual reactions which take place when rubber is chemically treated are not known, this exhibit has been very fascinating for the chemistry classes, as well as for others, who have seen it.

A glass exhibit has also been used quite effectively. All the materials for glass making, both the necessary ingredients and other substances used for the production of special grades, types, and colors of glass were employed in the project. Along with these materials the varieties of glass which they produce were used. For instance, small amounts of silicon dioxide, sodium carbonate, and lead oxide, together with the type of glass these produce, were shown. Different materials which are necessary to produce different colors, with the special color of glass produced, such as some cobalt compound used for blue glass, manganese compounds for pink or violet, depending on the amount used, and selenium compounds for a clear red glass, were shown.

The exhibit of carbon and some carbon products was, too, very interesting as well as beneficial. The allotropic forms of carbon (lampblack, graphite, and diamond) were shown together with their principal uses. Of course a substitution has to be made for the diamond. Some of the commercial uses of these were illustrated, not only by materials, but with literature concerning them. The materials necessary for the manufacture of carborundum were shown, with samples of carborundum and its uses as an abrasive.

One boy made a chart of valences and radicals. A large piece of white board used for sign painting served as a mount. He selected about thirty of the most common elements and about the same number of the most common radicals and arranged these in alphabetical order. The symbols for the elements with their valence and valences were printed on one section of the chart while the name, formula, and valence of the radicals were

printed on the other part of the board. Letters and figures were one and one-quarter inches high. The electrical charges carried by each radical were indicated with plus and minus signs after each formula, the number of marks indicating the valence. This chart has been used very much by the students as a help in writing formulas. The instructor has, several times during class, employed the chart as a means of instruction. The students were divided into two groups, a captain being appointed for each side. These chose their sides, and a formula "bee" was conducted. The names of compounds were called out by the instructor, first to one side and then to the other. The contestants would give the formula, and when one missed the person missing it would take his seat. As soon as half of the members of either team were down, one of them had the privilege of answering for one of his colleagues who had just missed and, if correct, would change places with the one who had missed. This helped to keep the interest and attention of the students after they had been put down. Likewise the formula was given and the student would give the name. After some drill in this fashion the chart was covered up and the contest continued without it. This has been an exceedingly good method by which to teach formulas, names of compounds, radicals, and valences, knowledge which ordinarily has very little interest for the students, and knowledge which is sometimes neglected.

There were many other projects both in form of displays and charts which have been used and are being used to a very good advantage in the chemistry classes. Space, however, is not afforded for discussion of all of them. However, it is hoped that some material in this article may be of value to other chemistry instructors, even though this as presented has been very incomplete.

The Use of Chrome Leather Waste. The chemical composition of chrome-tanned leather waste with a water content of 50% is approximately: protein, 35–45%; CrO $2^1/_2$–$3^1/_2$%; SO_3, 1–$2^1/_2$%. Hitherto this material has not been successfully utilized; glue prepared from it had a low viscosity and bad color. Dr. Stadlinger (Charlottenburg) describes (*Chem.-Ztg.*, April 18, **1928**) how these difficulties have now been overcome by the use of magnesium oxide instead of alkalies in the treatment of the waste. In the processes of Rinck (Am. patent 1,612,746—1926) and of Ellenberger and Schrecker (Ger. patent 457,725—1928), the leather waste is heated to boiling point with water and magnesium oxide, with or without the addition of a little alkali. The glue-containing liquid is drawn off and concentrated. The glue so prepared has a good color and smell, is neutral, but has a rather low viscosity. Chromium can generally be detected in small amounts. The author states that if the viscosity could be increased this material would be in many respects superior to other varieties. The use of nitrogen-containing leather waste as a manure is not advisable without first determining the chromium content. The problem of preparing chrome alum from it remains to be solved.—*Chem. & Ind.*, **47**, 1113 (Oct. 26, 1928).

A PRESCRIPTION FOR AROUSING ENTHUSIASM IN CHEMISTRY

ALYENE WESTALL, NEWTON COMMUNITY HIGH SCHOOL, NEWTON, ILLINOIS

The purpose of this paper is to describe a plan that was followed in the Newton Community High School, Newton, Illinois, in dealing with the topic "Nitrogen." The results, as evidenced by the quantity and quality of work done by the pupils as well as by their interest and enthusiasm during the study of the topic, were so satisfactory that it was felt that a description of the plan would prove suggestive to other chemistry teachers who may never have tried a similar procedure.

This scheme revolutionized the chemistry class from an ordinary one to one that fairly bristled with excitement. Each student seemed fired with enthusiasm and worked harder than "A" students had formerly. This lesson plan proved a tonic, for it toned up the class and gave it increased vitality. It is a sure antidote for class sluggishness.

A similar procedure could be outlined for any subject from grade school work to college work. This kind of a lesson plan appeals to every type of mind. Many teachers fail because they do not appeal to every type of mind. Their assignments are inadequate in that they do not reach the level of inferior students as well as the medium and superior ones.

The actual assignment as given to the chemistry class at Newton, Illinois, is given below.

Nitrogen

February 25—March 7

60 Points

TEXTBOOK ASSIGNMENT

Chapter XIX—"Nitrogen and the Atmosphere," Brownlee and others, "Elementary Principles of Chemistry," Allyn and Bacon, Boston, **1926,** pp. 237–51.

Chapter XX—"Nitrogen Compounds," *Ibid.*, pp. 251–74.

Study the above assignment and be able to answer the questions at the end of each chapter in the text. Answers to questions 1–13 at the end of chapter XIX are to be written out in ink and handed in on February 28th. Questions 1–13 at the end of chapter XX are to be treated similarly and handed in on March 6th.

Two examinations required of every one will be given. In order to qualify for the 60 points, one must make an average grade of 70. The first examination on chapter XIX will be given on March 1st; the second on chapter XX on March 7th.

ADDITIONAL REFERENCE MATERIAL

Bruce, G. H., "High-School Chemistry," World Book Co., Yonkers-on-Hudson, New York, **1928,** pp. 263–98.

Vivian, A., "Everyday Chemistry," pp. 161–84.

"The Chemistry Leaflet," Oct. 29, 1928, **2,** No. 8.

"The Chemistry Leaflet," Nov. 5, 1928, **2,** No. 9.

25 Points

1. Make a scrap book of not less than 10 pages. Newspaper clippings—cartoons—personal anecdotes—magazine articles—new experiments with nitrogen—any phase of nitrogen or its compounds. Additional points will be given for clever color schemes, good printing, clever arrangement of material. *Due March 1st.*

2. Every nitrogen-containing compound in the following list derived its nitrogen from the air. Choose one of the following and, by use of diagrams, chart the route it took in securing its nitrogen. Choice of: (*a*) silk, (*b*) woolen coat, (*c*) colors in clothing, (*d*) leather shoes, (*e*) beads, (*f*) umbrella handle, (*g*) fur, (*h*) velvet. *Due March 4th.*

3. Make a poster illustrating some phase of nitrogen or its compounds. *Due March 5th.*

4. "Fixed Nitrogen Price Policy in Germany." Article 600–750 words. *Due March 5th.* Reference: "The Chemistry Leaflet," **2**, 3 (Nov. 5, 1928).

5. "The Use of Nitric Acid in the Manufacture of Dyes." 600–750 words. *Due March 6th.* Additional points will be given for diagrams, samples of dyed cloth, etc.

CONTRACTS

5 points

Unless otherwise specified, *due March 4th.*

1. 5 slogans which emphasize importance of nitrogen or its compounds.

2. Prepare a "Nitrous Oxide Column." (Jokes: *i. e.*, personal jokes from lab. or classroom or old jokes doctored up—jokes pertaining to nitrogen).

3. "A Nitrogenous Maid." Type short article for bulletin board. *Due Feb. 26th.* May be found in "Chemistry Leaflet," page 10.

4. "Long Live Air." Type poem for bulletin board. May be found on page 15 in "Chemistry Leaflet." *Due Feb. 26th.*

5. Make an illustrated placard with these words.

"Nitrogen"

"There's vitamins in peas and beans
And there are proteins too;
It's Nitrogen, say thoughtful men,
From which the proteins grew."

Anonymous

The best will be selected for the bulletin board. *Due Feb. 26th.*

10 Points

6. Articles. Not less than 300 words.
   (*a*) Medicinal Uses of Nitrogen.
   List the medicines containing nitrogen compounds.
   (*b*) Nitrogen in Agriculture.
   (*c*) Laughing Gas. Page 16 in "Chemistry Leaflet."
   (*d*) Leaking Ammonia Perils 200 in House. Page 8, "Chemistry Leaflet."
   (*e*) A Breath of Air. Reference article "Another Bunch of Cycles," "Chemistry Leaflet," page 9.
   (*f*) Ammonia as a Refrigerating Agent.
   (*g*) Nitrogen as an Explosive.
   (*h*) Picric Acid. Give its formula and uses. May quote the following:
   "We can imagine a soldier marching to battle beneath a flag dyed with picric acid, to fall wounded by a fragment of a shell exploded with picric acid, and having his wounds dressed with picric acid at the field hospital."
7. Bring in a display of nitrogenous products carefully labeled.

ADVERTISEMENTS

Due March 4th

10 Points

Write an advertisement for one of the following: Chile saltpeter, saltpeter, household ammonia, picric acid, Butesin picrate (salve). If advertisement carries a picture or illustration 5 additional points will be given.

LABORATORY EXPERIMENTS

*Exp. 40, Preparation of Nitrogen.
*Exp. 41, Preparation and Properties of Ammonia.
Exp. 42, Ammonium Compounds.
Exp. 43, Preparation and Properties of Nitric Acid.
Exp. 44, Preparation and Properties of Nitric Oxide.
*Exp. 45, Preparation and Properties of Nitrous Oxide.

Must perform 5 experiments. The ones with a star before them are required to gain the 15 points toward an *A*.

The minimum number of points necessary for the final grades were: *A*—135 points; *B*—115 points; *C*—95 points; *D*—85 points. Any one earning less than 85 points received 0. To receive an *A* one must have earned the 60 points (for required fundamental work), at least 1 of the 25 points, and have performed the laboratory experiments.

The regular class discussions and laboratory work were carried out as before. During the course of study a trip was made to the ice plant, so the students could see how ammonia was used as a refrigerating agent. The different parts of the project lent outside interest to the regular class work. Points were awarded as the outside material was handed in, and a chart was kept of it. It came in with such rapidity that it was possible to have a complete change for the bulletin board every day for two weeks. The board proved so attractive that students flocked to the room and stated a desire for next year to come so they could take part in so interesting a course. Even other teachers marveled at the interest displayed by the class. Enough material was turned in to fill at least four or five good-sized notebooks.

The students were learning about nitrogen while they were doing something they liked to do. The advertisements, slogans, charts, nitrogen cycles, posters, scrap books, and articles on nitrogen were exceedingly clever. Here are a few of the slogans.

"Diamond Dyes—a nitrogenous product—to make that old dress like new."
"Nitrogen—Enricher of the soil."
"Nitrogen is in the air.
Nitrogen is in our hair.
Nitrogen is everywhere."
"Proteins make germs go wrong, and men grow strong."
"Nitrogen is as necessary to plant life as gasoline is to a Ford."

One girl brought in a "Nitrogen Tree," which was the outline of a tree

drawn on poster paper showing numerous articles, all containing either nitrogen or a nitrogen compound, hanging on the branches. An excellent nitrogen wheel with the articles placed on the spokes, was brought in by a heretofore poor student.

Summary of Material Turned in on Nitrogen

Fundamental Work

28 out of 29 students turned in answers to the 2 lists of questions assigned.
28 out of 29 passed 2 difficult examinations on "Nitrogen and the Atmosphere" and "Nitrogen Compounds." Each examination consisted of 50 questions (see the end of this article).
Each student earned 60 points for doing the fundamental work.

Scrapbooks, Posters, Articles

7 turned in scrap books.
22 turned in charts and posters.
16 turned in articles on "Fixed Nitrogen Price Policy in Germany."
1 turned in an article on "Opium."
4 turned in articles on "The Use of Picric Acid in Manufacture of Dyes."
Each student earned 25 points for doing the above work.

CONTRACTS

16 turned in articles on "Picric Acid."
9 turned in "Placards on Nitrogen," including the assigned poem and pictures to illustrate it.
5 turned in slogans (5) about nitrogen.
6 turned in Nitrous Oxide Columns.
3 turned in articles on "Nitrogen in Agriculture."
2 turned in articles on "Nitrogen."
2 turned in typed articles "Nitrogenous Maid" (this was limited to two).
2 turned in typed poem "Long Live Air" (this was limited to two).
1 turned in an article on "Ammonia as a Refrigerating Agent."
1 turned in an article on "Laughing Gas."
5 turned in articles on "Breath of Air."
6 turned in articles on "Leaking Ammonia Imperils 200 in Apartment."
3 turned in articles on "Medicinal Uses of Nitrogen."
Each student earned 10 points for doing the above work.

ADVERTISEMENTS

16 turned in advertisements. They advertised "Household Ammonia," "Butesin Picrate," "Saltpeter," and "Chile Saltpeter."
As was stated in the assignment, if the advertisement was accompanied by an illustration it received 15 points, otherwise it received 10 points.
13 out of the 16 submitted were accompanied by illustrations.

Laboratory Experiments

29 completed the assigned laboratory work. 15 points were earned for this.

Examination Questions and Results

At the end of the first week the following examination was given. Mimeographed copies were given to each student.

Place a + if statement is true and a − if statement is false, in the space provided before the statement.

Fill in the blanks—complete equations—or list answers as asked by each question.

Work carefully! Remember you must pass this in order to qualify for the 60 points.

— 1. Nitrogen is found mostly in a combined state in nature.
— 2. Nitrogen constitutes nearly $^4/_5$ of the atmosphere.
— 3. Life without nitrogen would be impossible.
4. Write formula for oxide formed when phosphorus is burned in presence of water. .....
5. When air is passed over heated copper what happens to oxygen of the air?
6. Can nitrogen be obtained from the above process? .....
7. $NH_4Cl + NaNO_2 \longrightarrow$
— 8. Ammonium nitrite is a very stable compound.
— 9. Nitrogen is slightly lighter than air.
—10. N_2 has a very disagreeable odor.
—11. N_2 has a lower boiling point than O_2.
—12. The large amount of N_2 in the air is due to its inertness.
13. Name 2 names that were first given to the gas that constitutes $^4/_5$ of the air.
1. .....
2. .....
14. Who was the first man to prepare N_2?
15. Who was the first man to coin the name "Nitrogen?"
16. What does the word "Nitrogen" mean?
17. Who was the first man to study the properties of N_2? .....
18. What is the formula for niter? .....
19. What is formed during an electrical storm? .....
—20. Ozone is an allotropic form of oxygen.
21. The formula for ozone is .....
—22. Ozone has a peculiar odor.
23. $N_2 + H_2 \longleftarrow$
24, 25, and 26. List 3 reasons why air is a mixture.
1. .....
2. .....
3. .....
—27. When air in a room is moist, evaporation, as from the skin and lungs, is retarded and we feel oppressed and uncomfortable.
28, 29, and 30. Draw a nitrogen cycle showing how plants and animals obtain N_2.
31. Name 5 other gases in air besides nitrogen and oxygen.
1. ..... 2. .....
3. ..... 4. ..... 5. .....
32. What 2 men discovered argon? 1. ..... 2. .....
33. The word "argon" means .....
—34. Helium is the lightest substance known.

—35. Recent researches have proved that helium results from the decomposition of radium.
—36. Nitrogen is a constituent of protoplasm and other proteins.
—37. The chief use of picric acid is that of making explosives.
—38. Picric acid is antiseptic.
—39. Silk, woolen garments, beads, and shoes are substances which contain N_2.
40. Write formula for laughing gas. .....
41. Are NH_3 fumes poisonous? .....
—42. The oxygen in the air is removed by animals and replaced by plant life.
43. Name 3 medicines that contain N_2. 1. .....
2. ..... 3. .....
—44. 25 pounds of air rests on each square inch of the earth.
—45. Water vapor is always present in the air.
—46. N_2 unites with practically all elements.
—47. N_2 supports combustion.
—48. Cooled to a very low temperature under pressure N_2 becomes a colorless liquid.
49. Name 3 substances that will take up water vapor if left exposed to the air.
1. ..... 2. ..... 3. .....
—50. Nitrogen is one of the most interesting elements we have studied so far.

At the end of the second week, the following examination was given. Mimeographed copies were given each student.

Place a + sign before statements that are true and place a − sign before statements that are false.

Finish equations, fill in blanks, or answer as indicated by questions.

— 1. No life without nitrogen.
— 2. The characteristic odor of NH_3 can often be noted in the vicinity of heaps of decomposing animal or vegetable refuse.
3. The equation for preparation of NH_3 by the Haber Process is .....
4. ..... is used as a catalytic agent in the Haber Process.
5. The equation for preparation of NH_3 in the laboratory is .....
— 6. Ammonia is a colorless gas possessing a characteristic, pungent, overpowering odor.
— 7. NH_3 is exceedingly soluble in water.
— 8. NH_3 is lighter than air.
— 9. The great solubility of NH_3 is shown by the ammonia fountain.
—10. Pure, dry ammonia is a very active substance.
—11. It is readily combustible in air.
—12. The most important chemical property of NH_3 is the basic quality of its water solution.
—13. NH_4OH is commonly known as "sal ammoniac."
—14. $NaNO_3$ is saltpeter.
15. $NH_4OH + H_2SO_4 \longrightarrow$
16. What substance other than ammonia, and ammonium hydroxide, does household ammonia contain? .....
17. Why is household ammonia valuable as a cleansing agent?
18. The cloudy appearance of ammonia is due to .....
—19. The most important uses of ammonia are as a refrigerating agent and for the preparation of ammonia water.
—20. Is there ammonia in the ice we buy at ice plants?

21. N_2O is called 1. ..... 2. .....
—22. NO is a heavy red-brown gas of disagreeable odor.
23. N_2O is used as an .....
24. How would you test for a nitrate?
25. Name 4 oxides of nitrogen. 1. .....
2. ..... 3. ..... 4. .....
26. What is *aqua fortis?* .....
27. What is *aqua regia?* .....
28. Why is HNO_3 a better solvent for Ag, Hg, and Pb than HCl?
29. What volume of air would convert 500 cc. of nitric oxide into nitrogen peroxide?
30. Name 3 chemical properties of HNO_3. 1. .....
2. ..... 3. .....
31. Write equation for reaction between copper and cold dilute HNO_3. .....
32 What does *aqua regia* dissolve? 1. ..... 2. .....
—33. One of the chief uses of potassium nitrate is for the manufacture of gunpowder.
34. Write formula for unslaked lime. .....
Write formula for slaked lime. .....
—35 All nitrates are decomposed by heat.
—36. $NaNO_3$ and KNO_3 when heated give up oxygen and are converted into nitrites.
37. Give a definition of "the fixation of nitrogen."
38. $NO + O_2 \longrightarrow$
$NO_2 + H_2O \longrightarrow$
—39. Many nitrogen compounds are used in explosives.
—40. *Aqua regia* furnishes nascent chlorine.
41. How many oxides does nitrogen have? .....
—42. Nitric acid reacts with few metals.
—43. HNO_3 has a characteristic color at ordinary temperatures.
44. What kind of apparatus is used in laboratory in preparation of HNO_3? .....
45. What color is NO? .....
46. What happens to NO when exposed to air? .....
47. Who discovered nitrous oxide? .....
48. Explain what is meant by the ammonium theory.
49. How is nitric acid formed naturally? Write the equation. .....
—50. Nitric acid does not attack fabric of cotton or woolen goods.

The results of these examinations were as follows: 26 out of 29 students made *A*, 2 out of 29 students made *B*, 1 out of 29 students made *C*. There were no *D's*, no *F's*.

22 out of 26 who made *A* earned more than the minimum required 135 points. The number of points above 135 ranged from 140 to 195. The following numbers represent the grades made while the figures in parenthesis give the number of students making that grade: 140 (2), 142 (1), 145 (6), 150 (2), 155 (6), 175 (1), 180 (1), 185 (2), 190 (1), 195 (1). There were many more *A's* than most pedagogical books insist one should have and there were no *D's* or failures. However, ample opportunity was given each student to do excellent work if he wished. The grade received is really a measure of the students interest and willingness to work.

POSTERS IN HIGH-SCHOOL CHEMISTRY

CHARLES H. STONE, ENGLISH HIGH SCHOOL, BOSTON, MASSACHUSETTS

One of the first problems of the teacher is to arouse in his students an interest in the subject taught. It is up-hill business trying to instruct a class which is not interested. For a number of years at our school we have experimented with various methods designed to awaken interest, stir enthusiasm, and stimulate students to more than their usual activity in the laboratory. These methods have proved more or less successful. This year we have directed the attention of the students to the preparation of chemical posters and with gratifying results.

The poster idea is by no means original with us. Other teachers have used it with success. The results of such use have been described in the pages of THIS JOURNAL and we here acknowledge our obligations to Miss Bell, Ridgwood, N. J., and to Miss Jacobs, Germantown, Pa., for ideas suggested by their admirable articles.[1]

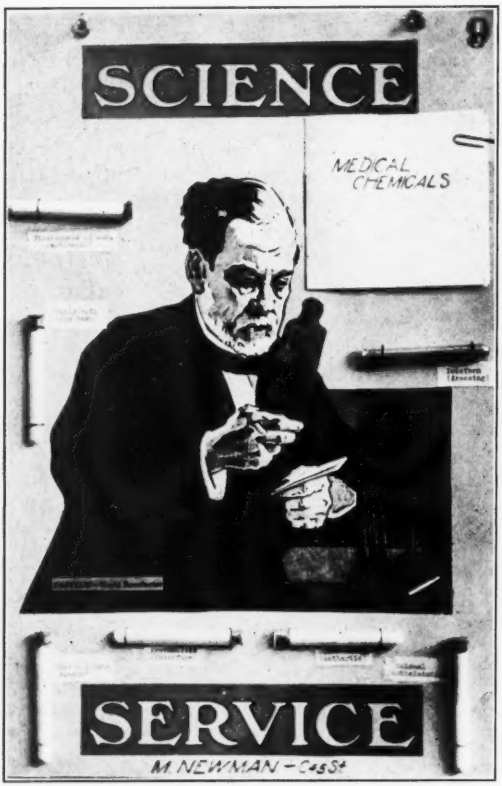
The posters we are now developing differ somewhat from those described in the articles by the teachers mentioned above in that the pupil is expected to prepare his own illustrative material in the laboratory rather than to make up his exhibit from pictures and clippings. Our method of procedure is as follows; a picture is chosen and mounted in the center of a sheet of cardboard 12 × 18 inches. Such pictures may be found in the advertising pages of the various magazines and may also be obtained from dealers and manufacturers. All direct advertising may be removed if desired. Colored pictures should be chosen if possible in order to add brightness and attractiveness to the whole poster. Around this central picture are then arranged small test tubes containing samples of the different materials prepared by the pupil in the laboratory. Such preparations may consist of different colored salts, pigments, simple dyes, and other similar material. A brief description of a few of these posters may be of interest.

Poster No. 1 was prepared by a student whose father is a physician. The pupil's interest being along medical lines, it was suggested that the preparation of a few of the simpler chemicals used in medicine would be appropriate and interesting, and the idea was acted upon. Around a large central picture of Pasteur are arranged 3-inch tubes containing; zinc sulfate (emetic), boric acid (eye wash), acetanilide (febrifuge), Epsom salts (cathartic), calomel (anthelmintic), iodoform (surgical dressing), sodium bicarbonate (anti-acid), and other specimens. All of these were prepared by the student. At one side of the exhibit the student has

[1] Fannie L. Bell, THIS JOURNAL, **5**, 157–67 (Feb., 1928). Adeline H. Jacobs, *Ibid.*, **2**, 792–4 (Sept., 1925). *See also* Hattie D. F. Haub, *Ibid.*, **4**, 1241–59 (Oct., 1927). J. E. Mahannah, *Ibid.*, **5**, 1112–6 (Sept., 1928). Ralph E. Dunbar, *Ibid.*, **5**, 531–5 (May, 1928).

attached a little book in which he has written on separate pages a brief account of how each of his preparations was made. Such work of course requires some time and energy but the student is well rewarded for the effort and takes pride in his accomplishment.

It was very amusing when, upon suggestion, the student doubtfully tasted a little of one of his products from the end of a cautious finger and burst out with: "Gee! It tastes just like the Epsom salts my father has at the office!"

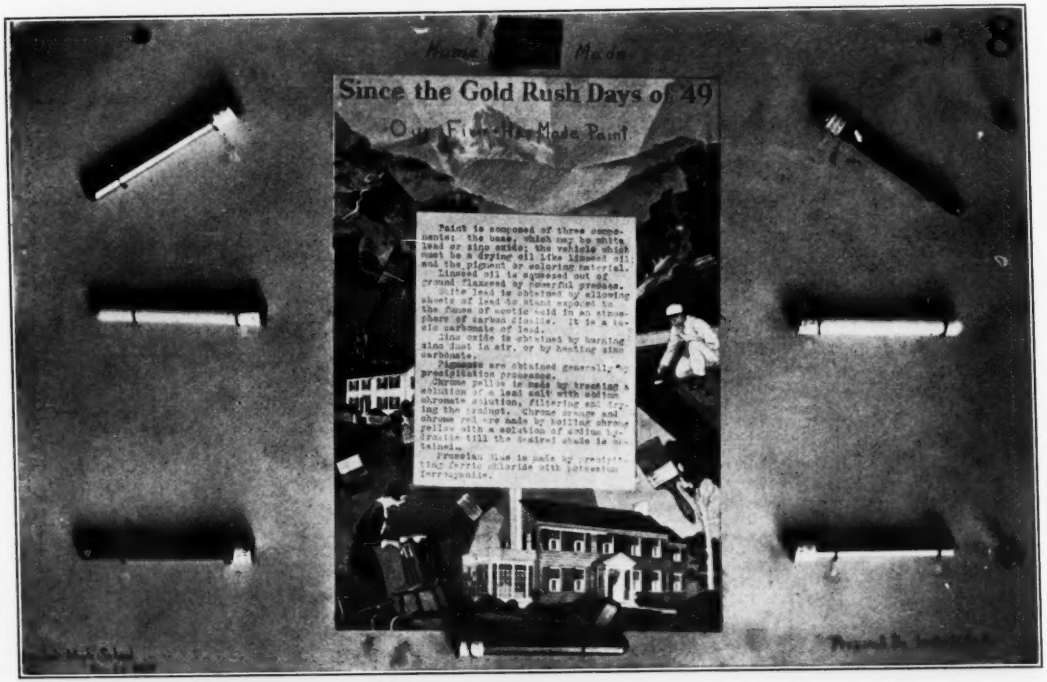


POSTER No. 1

Demonstrating the stimulation of enthusiasm through natural interests. The chemicals here shown were prepared by the son of a physician.

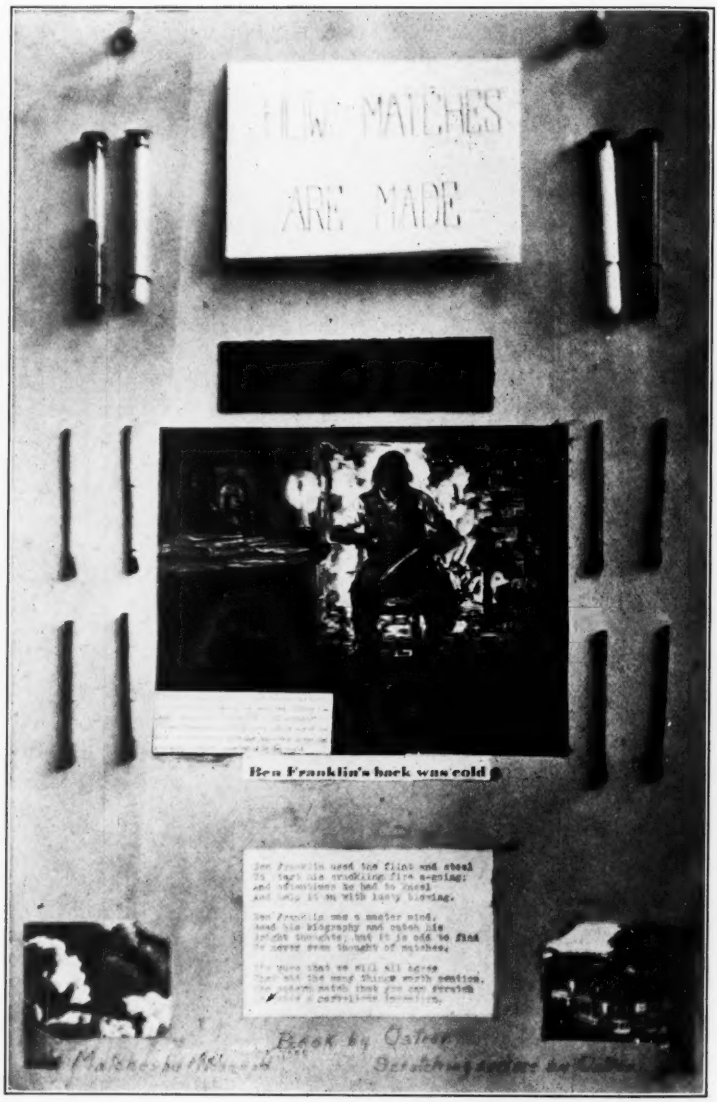
The father was doubtless rather skeptical as to the quality of his son's products, and justly so. No pretense is made that the preparations of students are chemically pure. Beginners can hardly be expected to produce that quality of product but the preparations made serve well enough to illustrate the basic processes of manufacture and provide the student with an opportunity to apply his growing knowledge of chemistry and what manipulative skill he may possess to a new and interesting project.

The materials for Poster No. 2 were prepared by a student who chose "Paint" as his theme. The central picture shows a colored advertisement of a well-known paint and color house, from which all advertising has been removed. Around this are arranged tubes containing various pigments and some electrolytic white lead, all prepared by the student.


Since the Gold Rush Days of 49
Paint is composed of three components: the base, which may be white lead or zinc oxide; the vehicle which must be a drying oil like linseed oil and the pigment or coloring material.
Linseed oil is squeezed out of ground flaxseed by powerful presses.
White lead is obtained by allowing sheets of lead to stand exposed to the fumes of acetic acid in an atmosphere of carbon dioxide. It is a basic carbonate of lead.
Zinc oxide is obtained by burning zinc dust in air, or by heating zinc carbonate.
Pigments are obtained generally by precipitation processes.
Chrome yellow is made by treating a solution of a lead salt with sodium chromate solution, filtering and drying the product. Chrome orange and chrome red are made by boiling chrome yellow with a solution of sodium hydroxide till the desired shade is obtained.
Prussian Blue is made by precipitating ferric chloride with potassium ferrocyanide.

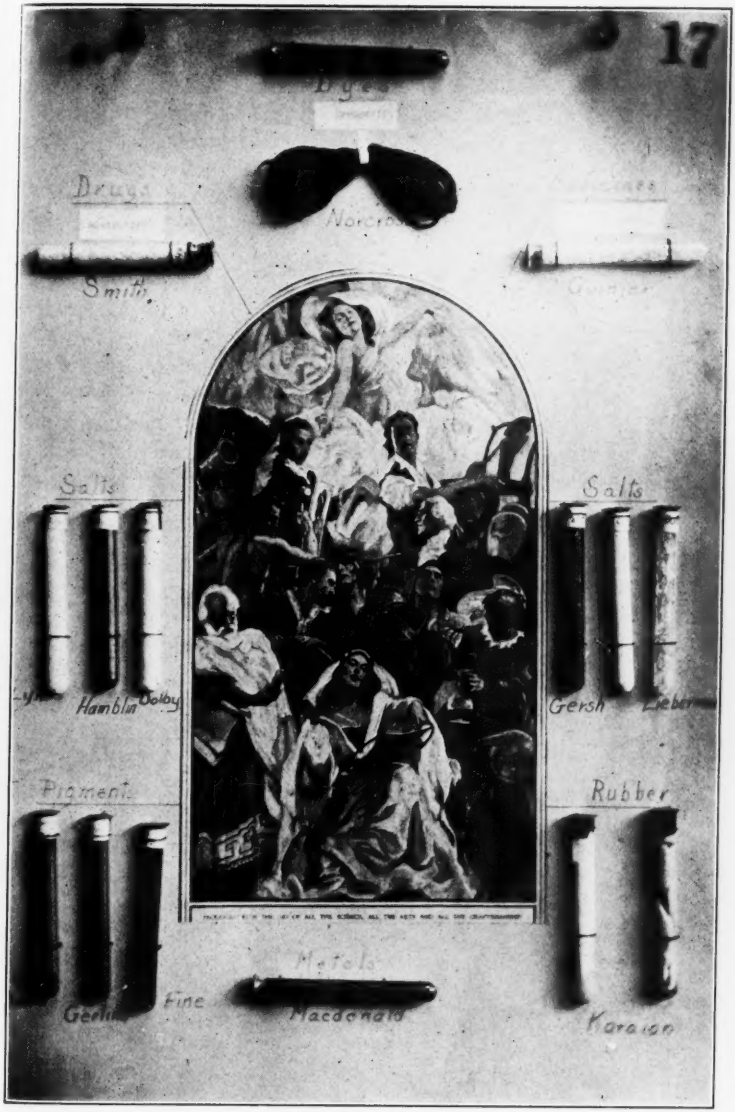
POSTER NO. 2

Exhibit of student preparations of materials used in the composition of paints.



POSTER No. 3

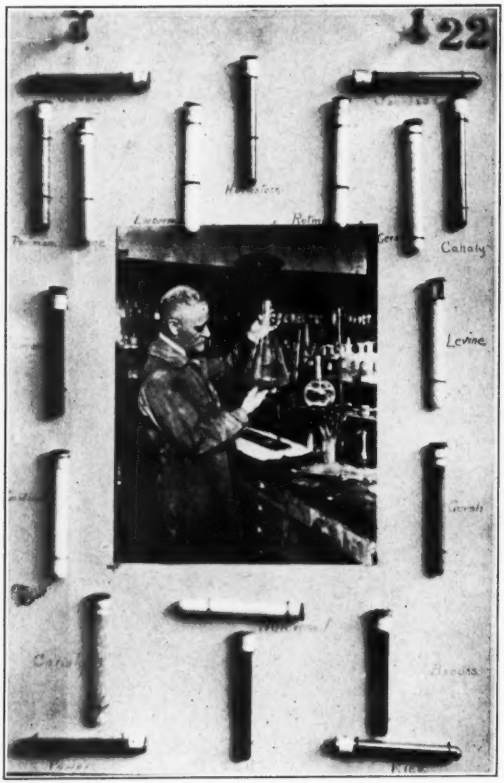
Two students who had experienced the satisfaction of making matches that work assembled this record of their achievement.



POSTER No. 4

A joint exhibit of various chemical materials.

The white lead was prepared according to the method described by Max Engelhart in the December 1927 issue of THIS JOURNAL. Above the central picture the student has attached a small square of cardboard painted with paint prepared from linseed oil and his own white lead and color. The whole is a pleasing piece of work and reflects credit upon the student who picked up a good bit of information about paint while doing the work.



POSTER NO. 5

Exhibit of colored salts, the preparations of a group of students.

Poster No. 3 was prepared by two students who chose as their theme "Matches." The central picture shows Benjamin Franklin sitting with his back to the fireplace where the flames of the wood fire are dancing. Below are shown three short verses setting forth that Benjamin had to use flint and steel to start his fire since matches were then unknown, and concluding with the triumphant assertion that "The common match that you can scratch is quite a marvelous invention." Above the picture the producers of the poster have mounted a little book describing how they made their matches and the accompanying striking surface. Around the center are arranged tubes containing the different materials used in match manufacture and there are also shown a number of the matches made by the pupils. These matches will readily light when drawn across the scratching surface provided. What youngster (or oldster for

that matter) would not like to undertake a piece of work of this sort?

A dozen or more boys united efforts in the production of Poster No. 4. The central colored design was taken from an advertisement of an automobile manufacturing company and carries the line of type below the design "produced with the aid of all the science, all the arts and all the craftsmanship." Around this are arranged samples of: a dye, with wool yarn dyed with the color; a drug; a medicine; six colored salts; three pigments; rubber and the latex from which it is made; and metallic copper produced by the reduction of copper oxide obtained from Malachite ore. This poster carries beside each tube the name of the boy who prepared the particular sample. This poster is one of the most attractive and interesting ones we have. It is unfortunate, however, that the photographs do not reproduce the colors of the poster, since much of its attractiveness is due to color.

Poster No. 5 was also a joint effort. The central picture was a full-page illustration in rotogravure in a leading magazine. It shows a chemist at work in his laboratory. The general title of this poster is "Salts" and around the central illustration are arranged a dozen or more of small tubes showing various colored salts prepared by different students. The name of each producer appears beside the tube showing his product. This makes a very interesting poster and it is quite effective. The boys take pride in having a sample of their work put up for exhibition in this interesting way.

It should be said that the preparation of these posters is only incidental. Boys must keep the regular work of the laboratory up to date before they can undertake work on posters or other illustrative material. This acts as a sort of spur to boys who otherwise might tend to lag behind the others. The posters simply provide an opportunity for interested and ambitious students to do something more than the mere requirement. We believe that the benefit derived from the increased interest and activity is well worth all the time and trouble it costs.

The posters described above were all done by boys. Equally interesting ones could be prepared by girls on such subjects as; Dyes and Dyeing, Soap and Cleaning Agents, Removal of Spots and Stains from Textiles, Preparation of Kitchen Chemicals, etc.

Teachers who seek a new avenue of appeal may find in the chemical poster one answer to their problem of how to awaken interest and stimulate activity in the chemistry class.

If we could have less activity on the part of the teacher and more activity on the part of the student, there would be more learning taking place in our university classrooms.—GROVER H. ALDERMAN

THE LAW OF DEFINITE PROPORTIONS

SIDNEY J. FRENCH, FRANKLIN COLLEGE, FRANKLIN, INDIANA

The generalization of definite proportions should be the most startling and, at the same time, most beautiful and orderly concept which the beginning student in chemistry meets. Yet, because of the difficulty of properly demonstrating the law and, perhaps, because the concept is no longer new or startling to the teacher, it is passed over rather lightly in the early days of the course. A clear, stimulating presentation of this topic should do much to provoke thought and orient the student to the full meaning of a chemical reaction. But, in addition to an adequate classroom discussion, the student should have first-hand laboratory experience to prove to him that this generalization is not merely a book law to be learned, but is a remarkable truth which he can demonstrate to his own satisfaction.

It is difficult to find a satisfactory experiment in definite proportions which the beginning student can perform and understand. Experiments involving the oxidation of metals such as magnesium are too difficult since they involve a gas as one of the reagents and the student has, as yet, no conception of the rôle of oxygen in oxidation. Likewise, the formation of copper oxide by dissolving copper in nitric acid and decomposing the nitrate to oxide is far too complex for the beginner to understand. If the student believes in the law of definite proportions after performing such experiments as these he does so because he has confidence in the veracity of his teacher and not because he has proved anything to his own satisfaction. The following experiment in definite proportions has been used here and has been found to be admirably suited to beginners since it involves simple technic and a simple observable combination of two elements.

When copper is heated in sulfur vapor, the reaction proceeds accompanied by a considerable glow to the formation of cuprous sulfide. The student is instructed to weigh out about one gram of sulfur and place it in the bottom of a hard glass test tube. He then weighs out exactly two grams of copper *turnings* which he wads up into a loose plug that may be easily shoved down into the tube but will not slide to the bottom. The tube is clamped at an angle of 45° and the sulfur is heated until it melts and begins to boil. The lower portion of the copper wad is then *also* heated until it begins to glow. It is not necessary to heat the copper further but the sulfur must be caused to boil vigorously. The glow will travel up through the copper wad and gradually die out at the top. The tube about the copper is then heated strongly for ten minutes or more to remove any excess condensed sulfur. Any sulfur remaining in the bottom of the tube may be also boiled off by playing the flame progressively along the tube. This assures the student that all of the sulfur has come in contact with the copper. When all of the excess sulfur condensed about the copper and

about the top of the tube has been removed the tube is cooled, then inverted over a white paper and tapped or jarred to remove the cuprous sulfide. The product retains the shape of the original wad and there is little danger of losing any during its removal. The experiment should be repeated using about one and one-half grams of sulfur but the same amount of copper as before. This assures the student that copper will take on only a definite amount of sulfur no matter how much may be available.

This experiment has been found to be almost fool proof. If no strands of copper are lost in the wadding process, and if heating is continued for a sufficient length of time the results are invariably good. Even if a good glow is not obtained, or if some of the copper melts during the reaction and runs down to the bottom of the tube the results are not vitiated. Using the triple beam balance and weighing to hundredths of a gram the error is generally not more than three per cent. The weight obtained is usually slightly higher than the theoretical value and longer heating reduces the error. The weight relations are quite simple, being four to one. It is not necessary to counterbalance any containers for both the copper and the cuprous sulfide can be weighed directly on the pan. The calculations are thus simple enough for the beginning student to thoroughly understand. Finally, the students seem to enjoy the experiment for they can see and understand the reaction both qualitatively and quantitatively. They discover the full meaning of definite proportions and gain considerable confidence in their ability to get things right.

Belgian Production of Radium. Belgium is now the world's principal producer of radium, which is extracted from ores brought from the Belgian Congo to a plant at Colen near Antwerp. These ores are obtained on such advantageous terms that the American production of radium has been adversely affected, and American supplies are largely obtained from Belgium. The by-products of this industry include uranium and cobalt salts, which supply mineral colors of value to glassworks and ceramic factories.—*Chem. Age*, **20**, 436 (May 4, 1929).

Turnover in the German Potash Industry. With a record year just passed showing sales of 1,420,000 metric tons of K_2O against 1,230,000 tons in 1927, the proceeds of the German potash industry averaged 16 marks per 100 kilos K_2O in 1928 as against $15^1/_2$ marks in 1927. The price increase may be attributed to the favorable effect of the Franco-German potash pact in export markets. It is estimated that the sales value of German potash in 1928 amounted to 230,000,000 marks, as against 190,000,000 marks in 1927. Profits were increased by sales of syndicated and non-syndicated by-products of the potash industry, including magnesium chloride, bromine, bitter salts (magnesium sulfate, tech.) Glauber salt (sodium sulfate), caustic potash, etc. This group of products yielded probably 15,000,000 marks gross profit. Sales of rock salt, concurrent in German potash mining, also yielded another 15,000,000 marks, so that the entire industry with by-products showed a gross value of 260,000,000 marks against a corresponding prewar figure of but 200,000,000 marks. Out of the 1928 German potash fertilizer sales, the domestic market took 61 per cent, and 39 per cent was sold abroad.—*Chem. Age*, **20**, 462 (May 11, 1929).

A LABORATORY EXPERIMENT ON THE BOILING-POINT CURVES OF NON-AZEOTROPIC BINARY MIXTURES

GEORGE W. BENNETT, GROVE CITY COLLEGE, GROVE CITY, PENNSYLVANIA

The usual laboratory experiments on the distillation of binary liquid mixtures have a common fault in that they provide either data for only the liquid phase and not the vapor phase over the entire range of concentrations, or else they give data for the composition of both phases for only a limited portion of the concentration range. This difficulty is, of course, due to several factors such as the difficulty of analysis, the limitations of the systems, and the cost of reagents for the most appropriate systems.

It would be very desirable if there were available to us laboratory experiments to illustrate the principles of distillation of the three types of binary liquid mixtures in which the composition of both phases over the entire composition range could be shown, and for which only the usual laboratory liquids might be used. It is the purpose of this paper to describe such an experiment for non-azeotropic mixtures. Since these systems illustrate the fundamental principles of all three types of systems it would seem that laboratory instruction should place as much emphasis on the non-azeotropic as on the azeotropic types. The very great number of azeotropic systems, moreover, warrants the thought that perhaps simple systems after all may not constitute a preponderatingly large fraction of all distillation mixtures. In a future paper it is hoped that experiments of a similar nature may be described for azeotropic systems.

Procedure

The systems used in these experiments were methanol–water, acetone–water, and acetic acid–water. Water is a common constituent because the analysis is made by means of a surface tension-composition curve, and to obtain the desired accuracy there must be a wide difference in the surface tensions of the two liquids. The organic constituents with water, moreover, illustrate three widely different types of boiling-point curves.

The analysis of the samples is readily effected by determining the surface tension of a small portion of the liquid. The value so obtained is then compared to a reference surface tension-composition curve, and the composition of the sample is found from this curve. Mixtures of water and one of the other liquids of known composition by weight are made, and the surface tensions of these mixtures are determined by the du Nuoy tensimeter. This instrument permits of a very rapid determination of the surface tension with an accuracy sufficient for the purpose.

Since, however, methanol and acetone are quite volatile it is not possible to use a watch glass, as is usual, to hold the sample during the determination because the composition of the sample alters more rapidly

than the surface tension can be determined. In order to obviate this difficulty a small straight-walled sample jar, 3 cm. by 5 cm., is used to hold the sample. The platinum loop of the instrument is lowered by means of a hook 3 cm. long attached to the arm of the tensimeter. The tension in the wire is then increased so that zero reading is obtained. Such a small vessel does not alter to an appreciable degree the value for the surface tension of pure liquids as determined in a wider vessel.

The surface tension values corresponding to the known compositions are plotted on coördinate paper, and the reference curve is then drawn through these points. We have used the scale values on the instrument instead of dynes, since the range on our tensimeter is almost fifty per cent greater, and therefore permits of greater accuracy when reading from the curve. For much the same reason weight per cent is to be preferred to the mol fraction when plotting the composition. The scale values of the instrument, then, are plotted against weight per cent composition.

For the distillations the following apparatus is used. A 500-cc. Claissen distilling flask[1] contains the liquid mixture to be distilled. The straight neck of this flask carries a ground glass stopper through which passes a tube that reaches almost to the bottom of the flask. This tube is bent at an angle of 135 degrees to perpendicular above the stopper, and the end is closed by a short section of rubber tubing and pinch-clamp. In the curved neck of the flask a ground glass stopper has a 2-cm. long nipple through which a thermometer may be passed. The thermometer is held in place, with its bulb opposite the delivery tube, by a piece of rubber tubing 1 cm. long which fits over the thermometer and the glass nipple on the stopper. Only a band of rubber about 1 mm. wide, therefore, comes into contact with the vapor. A straight tube condenser joins the delivery tube of the Claissen flask. At the lower end of the condenser there is an adapter which bears a cork. The samples are collected in side-necked test tubes which may be slipped on over the cork on the adapter. A thirty-inch piece of rubber tubing fits onto the side arm of the test tube.

Samples for analysis are taken as follows. The mixture is boiled at the rate of 2–3 drops a second until 15 cc. has passed over into a graduate. A few small pieces of porous tile in the flask will, of course, prevent bumping. The graduate is removed, a test tube with the rubber tube attached to the side arm is slipped onto the cork on the adapter, and the temperature is read. After 5 cc. of liquid have collected in the receiver the temperature is read again, and a sample from within the flask is taken. The pinch-clamp on the rubber, which closes the end of the tube in the straight neck of the flask, is opened, a test tube is placed over the end of the tube, and the operator forces 5–6 cc. of the liquid into the receiver by blowing on the end of the rubber tube connected to the side arm of the distillate re-

[1] This apparatus was made for us by the Corning Glass Works, Corning, N. Y.

ceiver. The whole operation requires only a few seconds, and the samples are taken without interrupting the ebullition. The samples are immediately transferred to glass-stoppered bottles until the surface tensions of the various samples are measured.

One would prefer both the apparatus and the method of sampling described by Othmer[2] to the apparatus and method described here, but the cost of such apparatus inhibits its use in the college laboratory.

The samples are brought to 20°C., and the surface tension is read with the tensimeter. An average of three closely checking values is taken as the accepted value, and the per cent composition is then read from the surface tension-composition curve. Absolute cleanliness is, of course, imperative to the success of the analysis. The platinum ring is frequently flamed and the glass is kept grease-free.

Typical Experimental Details

The accompanying tables and graphs give some typical details of the results we have obtained.

TABLE I

DATA FOR THE SURFACE TENSION-COMPOSITION CURVES

Methanol–water		Acetone–water		Acetic acid–water	
Surf. tens.	Wt. % CH_3OH	Surf. tens.	Wt. % CH_3COCH_3	Surf. tens.	Wt.% CH_3COOH
111.2	0.0	111.5	0.0	111.0	0.0
99.3	3.2	100.0	1.6	100.5	2.1
93.0	6.4	93.5	3.2	95.7	4.2
85.2	11.5	86.0	6.5	88.0	8.4
78.2	16.6	76.6	11.5	83.2	12.5
69.9	25.4	70.8	16.5	78.7	16.8
62.8	34.6	63.2	25.3	76.0	20.8
57.5	44.3	57.5	34.5	70.5	31.0
52.8	54.4	52.5	44.2	65.8	41.2
48.8	65.0	49.8	54.3	62.5	51.2
45.1	76.1	46.2	64.9	59.7	61.2
41.3	88.9	44.5	76.0	56.5	71.0
37.5	100.0	41.5	88.9	53.3	80.8
		38.8	100.0	50.0	90.4
				45.0	100.0

In Table I the data for the surface tension-composition curves are given. The values for the surface tensions of mixtures of known composition, in scale units of the tensimeter, and the compositions of these mixtures are given in adjoining columns. In Table II the data obtained in a typical distillation are given for each of the three systems discussed. In the first column is stated the temperature at which the vapor (column 2) and the liquid (column 3) have the composition in weight per cent of the constit-

[2] *Ind. Eng. Chem.*, **20**, 743 (1928).

uent stated. The barometric pressure in each case is that at which the distillation was performed.

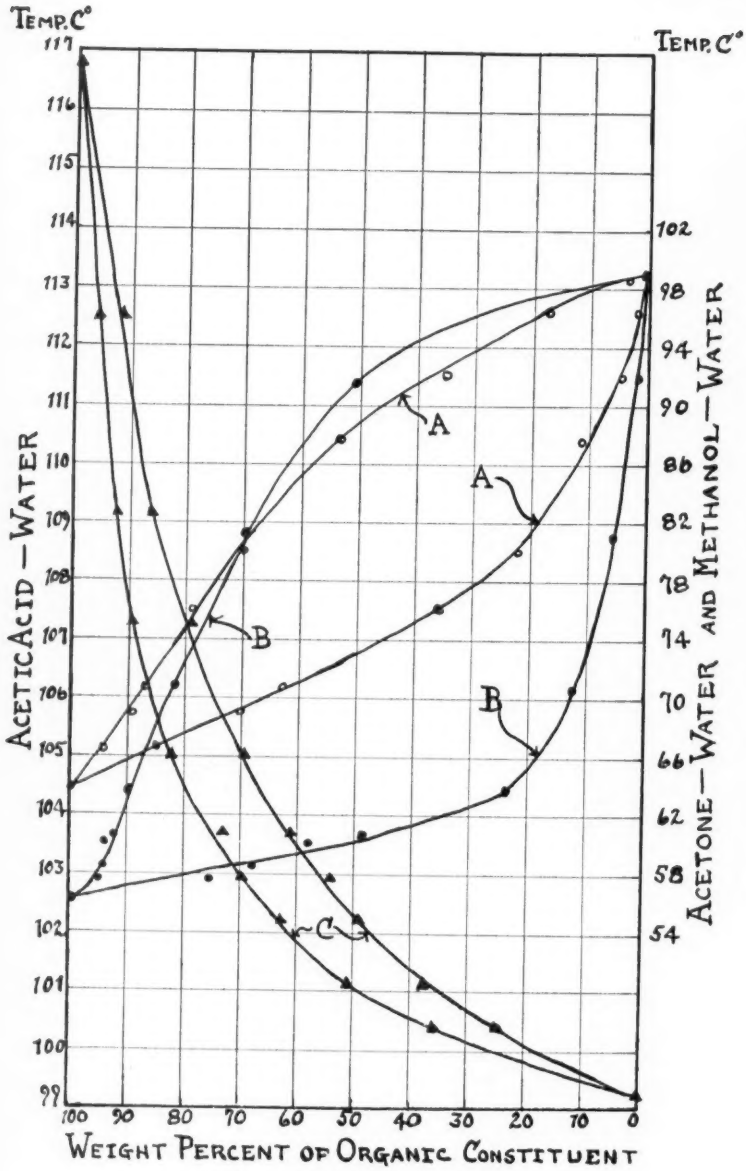
TABLE II

DATA FOR BOILING POINT-COMPOSITION CURVES

Methanol–water			Acetone–water			Acetic acid–water		
Temp., °C.	Methanol in vapor	Methanol in liq.	Temp., °C.	Acetone in vap.	Acetone in liq.	Temp., °C.	Acid in vapor	Acid in liq.
63.7	100.0	100.0	54.9	100.0	100.0	116.8	100.0	100.0
66.4	94.5	85.0	57.4	95.0	75.5	112.5	92.0	96.0
68.7	89.0	70.5	58.3	94.0	68.0	109.1	86.5	92.0
70.6	87.0	63.0	59.0	94.0	58.0	107.3	79.5	89.5
75.9	79.0	36.0	59.4	92.0	48.5	105.0	70.0	82.5
80.1	70.0	22.0	63.5	90.0	23.5	103.7	61.0	73.0
87.5	53.3	11.5	70.6	82.0	12.5	102.9	54.0	70.0
92.3	35.0	4.5	81.2	70.0	5.5	102.2	49.5	62.5
96.5	17.0	1.5	91.4	50.5	2.0	101.1	37.5	51.0
99.2	0.0	0.0	97.8	9.5	1.0	100.4	25.0	36.0
			98.5	3.5	0.5	99.2	0.0	0.0
			98.8	0.0	0.0			
Barometer 735.0			Barometer 726.2			Barometer 735.0		

In the figure on page 1548 the compositions of the vapor and the liquid phases in weight per cent of the organic constituent are plotted against the temperature of the vapor of the boiling mixture. The curves marked *A* refer to the system methanol–water, those marked *B* to the system acetone–water, and those marked *C* to the system acetic acid–water. The temperatures to the right of the diagram refer to the systems methanol–water and acetone–water, while those at the left of the diagram refer to the system acetic acid–water.

An account of the details of a given distillation would require too much space so it must suffice to sketch these details. In the case of methanol-water and acetone–water, 225 cc. of the pure organic liquid are placed in the distilling flask and its boiling point is determined. The distillate of pure liquid is returned to the flask and 25 cc. of water is added. Then 15 cc. of the liquid is distilled, the temperature is read, and 5-cc. samples of both vapor and liquid are taken for analysis. Twenty-five cc. of water is then added to the flask, and the distillation is continued as before. The volume of the liquid in the flask is kept approximately constant throughout a distillation. When the temperature of the vapor approaches that of pure boiling water, the contents of the flask are removed and the boiling point of pure water at that barometric pressure is noted. With acetic acid–water, however, the immediate addition of 25 cc. of water lowers the boiling point of the mixture too much. In this case only 5 cc. of water and the 15 cc. of distillate are returned to the flask. As the temperature of the boiling mixture falls, more water and sufficient distillate to make 25 cc. are added to the flask after the samples are taken.



BOILING POINT-COMPOSITION CURVES

Near the lower end of the curves one may remove as much as 75 cc. of the mixture from the flask and replace that volume by water before taking the next sample. For laboratory instructions each instructor might work out these details in full.

The materials used were all carefully purified. The methanol was of "Eastman" grade, and acetone-free. A fraction boiling at 64.6–64.7° was used. The acetone was fractionated, and a fraction boiling at 56.3–56.4° was used. The acetic acid was also of "Eastman" grade, 99.9% pure, melting at 16.6°, and boiling at 118.0–118.1°. All the boiling points are corrected to 760 mm. pressure. Ordinary wood alcohol contains acetone which forms a minimum boiling mixture, and hence it cannot be purified by simple fractionation. The usual laboratory acetone is readily purified. Ordinary glacial acetic acid contains so much water that it is difficult to get a constant boiling point with this material, but if the reference curve is once made with C.P. acid, and if the boiling point of the acid be calculated to the required barometric pressure, then glacial acetic acid can be used in the distillations.

Discussion

The experiment as outlined is not, of course, a precision method, and one cannot lay claim to the correctness of the absolute values found. In this experiment as in most of the others there is the inevitable interruption of the ebullition for the purpose of altering the concentration of the mixture in the flask, and although the samples are small the volume of liquid in the flask is not 100 to 200 times as great as the volume of the distillate as has been suggested is necessary.[2]

The tensimeter can be read so that errors of analysis are about of the order of one per cent, but two sets of distillation curves do not usually coincide because the barometric pressure may be different when the two distillations are made, but it is chiefly because the rate of distillation is not the same in the two cases. It scarcely needs to be pointed out that different tensimeters will not give the same scale readings for the surface tension of a given liquid.

The time required for a distillation is usually about two and one-half hours, and a like period is needed to make the surface tension readings so that two students can perform the entire experiment in one afternoon, provided the apparatus has been previously thoroughly cleaned with hot chromic acid-sulfuric acid mixture.

Summary

This paper outlines a laboratory experiment for plotting the boiling point curves of non-azeotropic binary liquid mixtures for both vapor and liquid phases over the entire composition range.

TESTING A REAGENT AS A LABORATORY EXERCISE IN QUANTITATIVE ANALYSIS*

W. D. COLLINS, U. S. GEOLOGICAL SURVEY, WASHINGTON, D. C.

In reports of chemical investigations that appear in the journals it is not unusual to find the quality of reagents used indicated by stating the maker's name without any account of work by the authors to establish the purity or strength of the reagents, even sometimes when the whole investigation depends on the quality of the reagents. This might be a reasonable procedure if the literature showed a long history of accurately determined agreement between the manufacturer's claims and the composition of reagents. Unfortunately, most of the published material[1] on the subject has been on the lack of agreement and the unreliability of the claims for purity of reagents. The articles noted may not represent present conditions, but so long as any uncertainty remains it is dangerous to use for serious work reagents that have not been tested by the user.

One of the chief reasons for the unreliability of reagents in the past has been the anxiety of purchasers to buy at the lowest price and thus discourage manufacturers who might wish to put into their reagents the work necessary to insure uniformly high standards of purity.

Any course in quantitative analysis might include at least one exercise on the testing of some reagent for strength and purity. Samples of various grades can be obtained easily. The reagent to be tested should be selected with reference to the student's experience. A teacher giving such an exercise could use it to obtain better knowledge of the grade of reagents purchased. The students should better appreciate the importance of tests of reagents. Both might be led to appreciate how absurdly low the prices of reagents are in view of the work involved in testing them, to say nothing of the pains that must be taken in manufacturing and purifying chemicals to make them approach reasonable standards of purity for reagents.

Directions for testing reagents have been available for a long time in books like the U. S. Pharmacopeia and Murray's Standards and Tests for Reagent and C. P. Chemicals. Recently standards and tests for many reagents have been published[2] by the Committee on Analytical Reagents of the American Chemical Society. Standards and directions for testing have been distributed by manufacturers of reagents. The directions are readily available. It is necessary only to select for test the reagents whose examination will best fit into any particular course.

* Presented before the Division of Chemical Education at the 77th Meeting of the American Chemical Society, Columbus, Ohio, April 29 to May 3, 1929.

[1] *J. Am. Chem. Soc.*, **15,** 501 (1893); **26,** 1644 (1904); *Ind. Eng. Chem.*, **9,** 109 (1917); **11,** 1140 (1919); **12,** 800 (1920); **15,** 529, 1281 (1923).

[2] *Ind. Eng. Chem.*, **17,** 756 (1925); **18,** 636, 759 (1926); **19,** 645, 1369 (1927); **20,** 797 (1928); *Anal. Ed., Ind. Eng. Chem.*, **1,** 171 (July 15, 1929).

APPARATUS FOR ELECTRO-ANALYSIS

M. L. NICHOLS, CORNELL UNIVERSITY, ITHACA, NEW YORK

In the equipment of a laboratory for the instruction of students in analytical chemistry, it is desirable to have some form of apparatus for electro-analysis. Several forms of such apparatus are available from dealers in chemical supplies but these do not give sufficient flexibility. Other forms have also been described[1] within recent years.

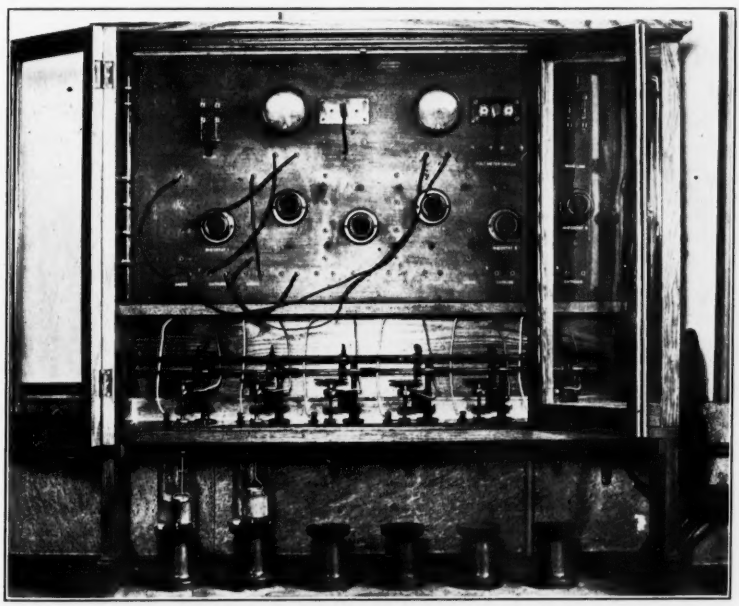


FIGURE 1.—APPARATUS FOR ELECTRO-ANALYSIS

The apparatus which is described has been in use in the analytical laboratory at Cornell University for about five years. In the design of this apparatus the desirable features of the forms which had been described were incorporated with the idea of obtaining a compact, strong unit of maximum flexibility, at a reasonable cost.

The apparatus shown in Figure 1 consists of six units mounted in a wooden cabinet which is about 45 inches high, 46 inches long, and 12 inches deep. This is divided into three compartments, the bottom one for the vessels is 12 inches high, the middle one for the stirring apparatus is 10

[1] Ziegel, *J. Am. Chem. Soc.*, **36**, 1450 (1914). Jones, *Trans. Am. Electrochem. Soc.*, **32**, 329 (1917). King, *Chem. & Met. Eng.*, **21**, 25 (1919).

inches high and the top one for the panel is 20 inches high. The two upper compartments are inclosed, with a removable wooden back and folding glass doors on the front, to protect the enclosed apparatus from any laboratory fumes.

The details of one of the stirring units is shown in Figure 2. *A* is the drive shaft of $^1/_4$-inch steel rod. It is cut and joined at five places by the brass sleeves, *B*, to permit the removal of any single unit. The drive shaft

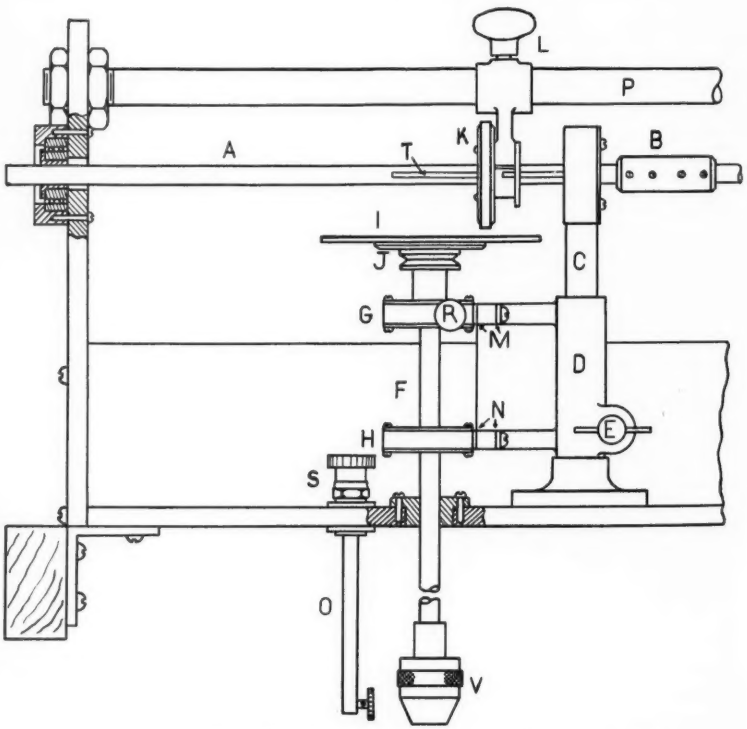


FIGURE 2.—DIAGRAM SHOWING DETAILS OF ONE OF STIRRING UNITS

is supported in the end plates and in each of the six posts, *C*, by self-aligning ball bearings. At the right end the drive shaft is connected to a $^1/_8$ h.p. motor of 1800 r. p. m., by a series of pulleys supported on a bracket, which is fastened to the end of the cabinet. The drive shaft has a speed of 220 r. p. m. The supporting posts, *C*, are of 1-cm. brass rod and are surrounded by the brass sleeves, *D*, which may be raised or lowered and held in position by the screw, *E*. The sleeve, *D*, supports the cathode shaft, *F*, by the two

ball bearings, G and H. The plate, J, at the top of the cathode shaft is one of those used on the Cenco friction-drive universal motor stirrer and carries the driving steel plate, I, which is 7 cm. in diameter. The cathode shaft is driven by the rubber disk, K, which may be moved along the drive shaft by the keyway, I, and is held in one position by the set screw, L, and the $^{7}/_{16}$-inch brass rod, P. By means of this arrangement the speed of rotation of the cathode shaft may be varied from 110 to 650 r. p. m. The electrical lead from the panel is fastened to the cathode shaft by the screw, R, and the shaft is insulated from the base plate by fiber inserted at M and N and by a fiber sleeve surrounding the shaft where it passes through the base plate. The anode holder, O, is also insulated from the base plate by fiber and the electrical lead from the panel is fastened to it by the screw, S. The anode and cathode shafts and the chuck, V, which has an opening varying from 0 to $^{5}/_{32}$ inch, are made of monel metal to prevent corrosion.

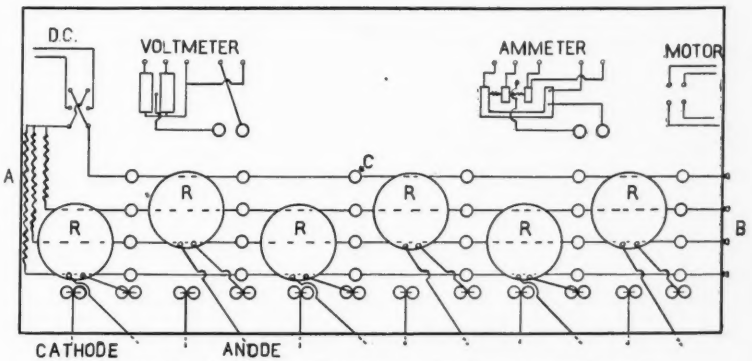


FIGURE 3.—THE WIRING DIAGRAM OF THE REAR OF THE PANEL

The base and end plates are made of the same material. The rest of the apparatus is protected from any fumes by the cabinet and is made of steel and brass.

The wiring diagram of the rear of the panel is shown in Figure 3. The current may be supplied by the ordinary direct current line in which case the resistances, A, must be inserted to give variable voltages. If current from a set of storage batteries is available the leads may be connected directly to the binding posts, B. The ammeter has a range of 0 to 30 amperes and by means of shunts will indicate from 0 to 3 and from 0 to 1.5 amperes. The voltmeter has a range of 0 to 25 volts and by means of shunts will indicate from 0 to 10 and from 0 to 2.5 volts. All connections are made on the face of the panel by Union Radio Tip Jacks, C, instead of numerous switches. This simplifies the construction of the panel and still permits all desired connections to be made. Each of the six circuits contains a vari-

able field rheostat, *R*, mounted on the rear of the panel. The rheostats have a total resistance of 20 ohms and are capable of carrying a current of 4 amperes. These rheostats and the complete insulation of the anodes and cathodes permit a different current to be used simultaneously at each unit.

This apparatus has given complete satisfaction over a period of years, all parts are conveniently mounted and it may be constructed at a reasonable cost, considering the flexibility obtainable.

Ozone Thought Due to Particles from Sun. Two layers of ozone in the earth's atmosphere, one due to ultra-violet light from the sun, the other due, perhaps, to particles or corpuscles shot at the earth from sun-spots, were described at a recent meeting of the American Geophysical Union in Washington. In telling of his studies, Dr. F. E. Fowle, of the Smithsonian Institute, said that one of these layers of ozone, which is a form of oxygen, shows an annual period of change, depending on the position of the earth in its orbit. Probably, he thinks, it is due to ultra-violet light, which varies in intensity at different times of the year.

Unlike this layer, the second layer of ozone shows a close relationship to sun-spots. When the sun-spots are at their minimum number, it will probably be absent entirely, though the observations have not continued long enough to ascertain this. Dr. Fowle suggested that some emission of minute corpuscles from the sun-spots might account for this layer.—*Science Service*

Acid in Onion Makes It Resistant to Disease. An acid in an onion which kills a parasitic fungus when it attempts to prey upon it, thus playing the part of a vegetable antitoxin, has been isolated and chemically identified by three University of Wisconsin scientists, Dr. J. C. Walker, Dr. K. P. Link, and Dr. H. R. Angell. This discovery, believed to be the first of its kind ever made, was announced recently before the National Academy of Sciences.

The first clue was given by the fact that white onions were susceptible to the disease, while certain strains of colored onions were not. A search was made for some substance present in the colored onions, and absent in the white ones, that would stop the growth of the fungus. This was eventually found and upon analysis was shown to be an acid of the phenol series, known to chemists as protocatechuic acid. A purified solution of this acid was tried on the fungus; this also stopped its growth, thereby clinching the conclusion of the three experimenters.—*Science Service*

Living Trees Stained to Increase Wood Value. Maple that looks like mahogany or birch with the color of black walnut may soon become factors in the veneer and cabinet woods trade, as the result of experiments recently conducted in northern New England by W. R. Brown.

Through holes bored in the base of the tree with an electric drill, a dilute solution of dye is allowed to flow in from a 100-liter tank suspended on the tree and mingle with the sap. The coloring matter is absorbed and rises to the topmost branches of the tree within a few days. Reacting with some of the oxidizing ferments in the cell sap, it stains the wood a beautiful brown, dark purple, or other color according to the dye used.

New stains have been developed which almost exactly duplicate the shades of walnut, mahogany, and other woods prized for the beauty of their grain. The greatest advantage of the process is that the wood is completely dyed through and through, which was not possible with some of the commoner dyes at first tried. The wood is also rendered relatively immune to decay and insect damage, due to the antiseptic action of the stain.—*Science Service*

THE MINNEAPOLIS MEETING OF THE AMERICAN CHEMICAL SOCIETY

Program of the Division of Chemical Education*

WM. MCPHERSON, *Chairman*
R. A. BAKER, *Secretary*
H. H. BARBER, *Local Secretary*

MONDAY, SEPTEMBER 9

8:00 A.M. Breakfast Meeting of the Executive Committee.

11:00 A.M. Business Meeting of the Division.

TUESDAY, SEPTEMBER 10

2:00 P.M. Reading of Papers.

W. A. HAMOR AND LAWRENCE W. BASS. "Educational Activities of Mellon Institute."

W. G. BOWERS. "Laboratory Notebooks in the Teaching of Elementary Chemistry."

S. B. ARENSON. "Radio Reactions."

EARL W. PHELAN. "Objectives as Aids in the Choice of Subject Matter in High-School Chemistry."

T. A. SARVER. "Quantitative Analysis for Medical Students."

T. A. SARVER. "Colorimetric Determination of Ammonia by the Standard Series Method."

E. M. FREEMAN. "Educational Surveys."

CECIL L. BROWN. "Objective Tests in Organic Chemistry."

5:00 P.M. Meeting of Editors of the JOURNAL OF CHEMICAL EDUCATION.

6:00 P.M. Editors' Dinner.

WEDNESDAY, SEPTEMBER 11

8:00 A.M. Breakfast Meeting of the Senate of Chemical Education.

11:00 A.M. ALEXANDER SILVERMAN. "European Educational and Research Institutions." (Illustrated.)

12:30 P.M. Division and Senate Luncheon (Complimentary to high-school teachers of chemistry in the Minneapolis area).

2:00 P.M. **Symposium; Selecting the Chemist-Elect.**

HARRISON E. HOWE will preside and the following persons will discuss the fundamental training and qualifications which their respective organizations consider most important: IRVING LANGMUIR, General Electric Company; WM. J. HALE, The Dow Chemical Company; G. S. RUTHER-

* The complete program, for all Divisions, will appear in the August 20th *News Edition* of *Industrial and Engineering Chemistry.*

FORD, Western Electric Company; WEBSTER N. JONES, B. F. Goodrich Company; R. K. BRODIE, The Procter Gamble Company.

THURSDAY, SEPTEMBER 12

9:00 A.M. Reading of Papers (continued from Tuesday morning).
11:00 A.M. Business Meeting (Election of Officers).

Douglas, Arizona, Is Copper Town. Douglas, in Cochise County, Arizona, is a fine little city, named for Dr. James Douglas, a prominent mining expert and geologist, president of the great Phelps-Dodge mining company. The town was planned and built in 1904 by the Phelps-Dodge Company as a location for their great smelting plant. Because of lack of room the smelters were removed from Bisbee, where the copper mines are located. Douglas is also on the boundary line but the town on the Mexican side is called "Agua Prieta," which is Spanish for dark or black water.—*Science Service*

New English Textile Plant Seen Doubtfully by Scientists. "Brotex," the much-talked-of new fiber plant which has been hailed in the press as a "replace-plant" for cotton and a solution of Britain's textile woes, is apparently being received coolly and even somewhat doubtfully by British scientists. An editorial paragraph in *Nature*, a leading British scientific journal, examines the claims of the new plant critically and dismisses it, at least for the time being, with a Scotch verdict.

"That a plant with so many desirable qualities, which will survive the winter in the south of England, should only now have been brought to notice, is somewhat remarkable and merits further investigation," the editor remarks.

"The 'evolution of the plant' has not been disclosed, pending application for patents, though it has been stated elsewhere to be of hybrid origin. It is known, however, that it belongs to the genus *Lavatera* of the family *Malvaceae*, and the plants now being grown in Devonshire very closely resemble a species which is a native of the Canary Islands, a plant which would certainly be hardy only near the warm southwest coast of England in normal winters. The mallow family contains many well-known fiber-yielding plants...and in some cases the seeds are also of value for cattle food. None of these plants is hardy in Great Britain, and even *Lavatera arborea*, which is the only *Lavatera* found in England, will succeed only near the coast.

"If, therefore, 'Brotex' can be proved to be of hybrid origin, not only will it be of scientific value to know its parentage, but it will also be of material importance to know whether it will regularly produce fertile seed in Great Britain. Moreover, it is of importance, from the commercial aspect, to know whether the fiber is superior to jute and hemp, with which fibers we understand the market is already fully supplied."—*Science Service*

New Sugar Synthesized by U. S. Scientists. A form of sugar that does not occur in nature has been artificially put together by Edna Montgomery and Dr. C. S. Hudson of the U. S. Public Health Service. Their work was announced recently at the meeting of the National Academy of Sciences. Miss Montgomery and Dr. Hudson used common milk sugar as their raw material and by treatment in an alkaline medium obtained a substance analogous in structure with common table sugar, but having a different chemical nature. They call their new product lactoketose.

At the same session Dr. Hudson and Eugene Pacsu, a Fellow of the International Education Board, announced that they had succeeded in crystallizing turanose, a rare sugar which has never before been secured in a wholly pure form.—*Science Service*

Chemical Digest

THE THINGS THAT COUNT*

The following five "things that count" were agreed upon as being the most important things in their professional life by a group of professional men.

Education

First, of course, we put *education*. For this we chose the broadest definition. College merely opens a few doors. It teaches one *how* to obtain education rather than turning one out fully educated. It gives an opportunity to acquire some yardsticks whereby values may be measured, thereby leading one toward wisdom, which consists in choosing the best, whether new or old; ancient or modern.

Health

The second essential selected was *health*. A strong and sound body frees the mind and soul for great tasks. Many a genius has lived in a frail or afflicted body, but the world would doubtless be far richer if genius were always accompanied by health. Ill health was once regarded as an affliction to be borne with patience and fortitude. This viewpoint is passing. Man's knowledge of human anatomy, the chemistry of body functions, preventive medicine, and nutrition is reaching a point where most cases of ill health may be looked upon as evidences of carelessness or neglect on the part of the individual. Our ideas of medical service are approaching those of the Orient, where physicians are paid only to keep people well.

Income

Next, we selected *income* as an essential. Every man who is willing to contribute his share of effort has a right to a living wage. Poverty has no legitimate place in modern civilization. Any man whose ambition, training, and ingenuity enable him to *create* and add to the structure of civilization may reasonably expect more than a minimum wage. The compensation of the scientist or engineer with creative ability should be sufficient to free him from the worry of making ends meet. No man can do his best work with the wolf's shadow on his threshold.

Successful men who have risen from poverty are frequently used as in-

* M. E. Dice, "Paths of Progress," *The Hexagon of Alpha Chi Sigma*, **19**, 398–400 (May, 1929).

spiring examples. Pasteur wrote his father, "I am more than ruined by the cost of printing my thesis." Dalton was wretchedly poor. These men reached their goals in spite of poverty, not because of it. They might have left a far greater heritage had not so much of their energy been expended in obtaining their daily bread.

Sense of Social Responsibility

The fourth essential selected was a *sense of social responsibility*. The very complexity of modern life is taking scientists and engineers out of their laboratories and into the service of the people. Industry is becoming more and more conscious of its needs for technically trained executives. Demands for technical ability are increasing in all branches of public service. The scientific professions command the respect of the people as never before, simply because on every hand the fruits of technical skill are apparent. With recognition comes responsibility, and successful chemists must realize that they may no longer live in a house by the side of the road: their place is in the procession, helping to guide the onward march in paths of progress.

Spirituality

Fifth, but quite as essential as any of the first four, we placed *spirituality*. Wisdom, health, riches, and services to fellow men are transient. They exist only with life. Few, if any, of us think of death as the end of the rich experience we call life. Even in this rapid and preoccupied age, the beautiful mysteries of spiritual intuition have a tremendous power to guide the intellect. To consider the intellect the only human guide is boastful, for man's unaided intellect cannot see around the next corner. The deeper one delves into pure science, the more he is impressed with the orderliness of the universe, from the simplest atom to the farthest nebula in the heavens. Nothing in science denies man's instinctive hunger for belief in a Power greater than himself. The well-rounded chemist will not neglect, in his thirst for truth and facts, that corner of his mental life where he may reach beyond the farthest horizon of facts through the media of faith and belief. And because he is a scientist, he occupies an enviable position; through the researches of chemical and physical science he is able to appreciate in a finite way the beauty of infinite creation.

Cleveland Explosion. The explosion and fire which occurred at a Cleveland (U. S.) hospital recently, resulting in more than 120 deaths, were investigated by the Chemical Warfare Service Department of the United States Army. The Department reports that the deaths were caused by carbon monoxide and oxides of nitrogen, given off by burning x-ray films.

THE EFFECTIVE COLLEGE*

On the whole, we judge this to be quite a helpful book, foremost to the college administrator, secondly to the layman in awakening him to the problems the college must face. Dr. Kelley has chosen recent reports of leading educators throughout the country and classified them under the following sub-heads:

Ideals for the Effective College
The Effective College Curriculum
Faculty-Student Relationships
Effective Teaching
The Promotion of Scholarship
Music and the Arts of Design
Religion in the Effective College
Financing the Effective College
The College of the Future

One or two of the articles are quite forceful and outstanding; a few striking us as decidedly mediocre. We also feel that none of the subjects is treated fully enough. Perhaps the best group is the first; "Ideals for the Effective College." This consists of four articles. The first, "The American College of the 20th Century," by Frank Aydelotte, sets itself against "our quantitative theory of culture." However, after giving a very vivid description of the life of a student who attempts to be a "big college man," he says:

> But such a picture as this overlooks one important fact—that is, the saving discontent which we all of us feel, students and teachers alike, with the empty hurly-burly of college life. This is, after all, the rubbish on the glacier: below it the current is flowing slowly but irresistibly in the direction of saner and more real values.

The problem of the inferior student interests him too. Here is his final conclusion:

> For in the long run our civilization must be measured not by its material, but its intellectual and spiritual achievements; not by the wide extent of a low level of culture, but by the eminence of its mountain peaks.

The effective college of the future, he tells us, will be well endowed; it will be small, probably composed of federated units as we find the colleges of Oxford and Cambridge; it will be more expensive. All of these seem interrelated to a certain extent. Moreover:

> The college of the next generation will be less like a secondary school. It will assume more maturity in the student, allow him more freedom, and insist upon more serious work. . . . *It will give more special attention to the best students than to the poorest.*

* By a Group of American Students of Higher Education, edited by Robert S. Kelly. Published by the *Assoc. of Am. Colls.*, 111 Fifth Ave., New York, **1928.** ix + 302 pp. $2.00.

John R. Effinger, the author of the second article, "A Secondary Function of the College," sums up the needs of young America as "better mental training, harder study, less superficiality."

He presents as the secondary function of the college that of teaching students how to work.

Dr. Kerr D. MacMillan in the third article, "The Effective College Home," first states what he believes a college should accomplish.

> What we would like to do is send out young men and women who, first of all, have been trained to think steadily and carefully on any problem that is brought before them, and who think thus habitually. We wish them to have some information, too—very considerable information—about the complicated civilized world into which we are sending them. And finally, we would like them to approach this world of theirs and its problems with an attitude of the clear, high-thinking and intellectual honesty of the best Greeks, and the humility and sense of the rights of others and wrong in themselves that is our heritage from Palestine.

In the discussion of reasons for our ineffectiveness, we read:

> The modern undergraduate is very dispersed, almost scrambled. . . . It is hard to find him. . . . Still worse, the average student is not only lost to the view of the college authorities, he is lost to himself. The students in our colleges are so numerous and the student body is so lacking in any sort of coherence that the individual feels himself in a crowd where he neither knows or is known. He is open to the lower appeals of the mob mind and has little or no leading to discover and develop what is best in himself. One who is lost in a crowd is lost to himself.

The cure suggested is "to break up the great masses of students into groups" of about two hundred each. They will eat, sleep, and entertain, each in their own college house. They will eventually do away with fraternities for they will fill the need which fraternities now fill. The freshmen will be brought into close contact with the upper classmen and learn the ideals and spirit of the college. This will also be a valuable means for assimilating the foreign element.

A second remedy is that of requiring more "solid work" from the students.

In the fourth and concluding article of Part I of this publication, "The College within the University," the author, Max Mason, states: "I believe that real education is that participation and that education by participation is an experiment well worth trying." Adding to this his opinion that a "university had best consist of a group for personalities capable of inspiring curiosity and the physical equipment to enable the students to satisfy curiosity," Dr. Mason gives us his main argument that the most effective means of getting the students to learn is to attach them as assistants to the graduate students and let them grapple with real problems. Let them "feel that they have an opportunity for participation."

It is impossible for us to discuss each article of this publication, so that we shall merely comment on a few of the others.

Concerning "College Entrance Requirements," Clyde Furst says:

There is probably no other procedure in the student's entire academic life so significant as that of his admission to college; certainly there is no other single activity of a university or college that is so suggestive an indication of an institution's measure of enlightenment.

Ernest H. Wilkins in his article "Faculty-Student Coöperation" discussed the "Better Yet Campaign" of the University of Chicago which owed its success to the mutual participation of faculty and students. He concludes:

The experience of faculty-student coöperation carries in itself its own immediate reward in the friendly association of older and younger members of the same community; and it has, I believe, possibilities for educational development which we have hardly begun to realize.

Clarence C. Little also has an interesting article on this subject. He brings out an important point:

While I don't ever expect to see the figure of Mark Hopkins changed to a point where he and the students, instead of sitting on opposite ends of the log, are in the middle of the log with their arms around one another, still I do think that once in a while they might as well slide up a little bit closer, because in these days the noise of our materialistic civilization, as Dean Effinger has pointed out, makes them both slightly "hard of hearing," and to get a little closer to one another, realizing that their problems are almost identical, is, I think, the first step in the larger problem of a permanent type of coöperation.

Edward A. Pace's article on "Does Research Interfere with Teaching?" is written well and interestingly but only makes the generally accepted point, that few people can do both successfully. The best written and most thought-provoking of the articles is A. Lawrence Lowell's "The Outlook for the American College."

Unless the American college succeeds in convincing its own students, their parents and the public at large, that its main object is an education acquired by the personal effort of the student himself, it will pass away as an important factor in the life of our country.... The aim of the American college must be cultural, rather than vocational.... The charges of materialism hurled at us from other lands are only true in part; there is also a craving for better things, not withal inconsistent with physical well-being; and I believe that this craving will wax stronger as the nation becomes more mature.

Apparently the articles have been carefully chosen; our disappointment may be only personal. But we hope that Dr. Kelley's book is a forerunner of several such collections; they would go far toward clarifying the aims and obtaining means of accomplishment of *the effective college.*

M. W. G.

Tolerance is the even balance that enables one to believe or doubt without getting mad because the other fellow believes or doubts.

THE CHEMICAL EXPOSITION*

The Twelfth Exposition of Chemical Industries was held at the Grand Central Palace in New York City during the week ending May 11th. By far the greater proportion of the exhibits related to manufacturing processes. The standard operations of chemical engineering practice, such as grinding, mixing, filtration, evaporation, concentration, thickening, classification, and nitration, were all represented by numerous types of equipment, many of which have been developed since the exposition of two years ago. Yet, on the whole, chemical engineering practice is rapidly becoming standardized. It is only now and then that some completely new procedure wins a place for itself.

Automatic Control.—Chemical processes readily lend themselves to automatic control. A great plant, passing hundreds of tons of material a day through a series of complicated operations, may employ but a dozen laborers. There may not only be automatic control at every stage, but automatic continuous recording of conditions of operation, and frequently long-distance recording at a central station, where a bird's-eye view may be obtained of all the chief processes of the plant, at any instant. Humidity, temperature, pressure, acidity, rate of delivery of gas or liquid, composition of furnace gases, thickness of films, velocity of motion, liquid levels, weights of raw material and product, electrical voltage, current, and power are all commonly subject to automatic control or record. An interesting piece of equipment was exhibited which may be set to deliver liquids intermittently, in successive portions of a given volume, at a given temperature.

Colloids.—Increasing attention is being given to colloids. In industrial practice, though not of theoretical necessity, this class of materials includes those that are crystallizable with difficulty, if at all—such things as water glass, glue, starch, casein, resins, and textile fibers. Colloid mills of several different types were exhibited for the production of very finely divided suspensions and emulsions in the manufacture of paints, inks, polishes, and medicinal preparations. Homogenizers and emulsifiers, for the dairy, insecticide, textile, and food products industries, have been brought to a high degree of perfection. Ultrafilters for preparing sterile media and supercentrifuges for separating very finely divided solids from liquids are now so familiar as to attract little attention in an exposition of this sort, though they were novelties ten years ago.

The lay visitor was perhaps more impressed by the products of the chemical industries than by the engineering equipment that made these products possible. Such comparatively new or unfamiliar products were exhibited as the new extremely hard cobalt-tungsten carbide alloy, carboloy; elkonite, a copper-tungsten alloy to replace copper electrodes for spot welding; new applications for the rare metals molybdenum, columbium, and tanta-

* *Ind. Bull.*, Arthur D. Little, Inc., No. **30**, June, 1929.

lum; and seamless welded equipment of many different kinds, fabricated by electric welding of chrome and chrome-nickel stainless steels.

New Plastics.—Among organic products, plastics were exhibited in great variety. Articles which a generation ago were laboriously fashioned from wood, or which were made of glass or porcelain with consequent great danger of breakage, are now fabricated by molding. Hard rubber and Bakelite have long been familiar. These, and numerous new plastics, appeared in hundreds of molded articles, intended for use in the household and the most diverse arts and industries.

Chemical research in this field has become the despair of lexicographers, for many new words have suddenly appeared, descriptive of new plastics: Lumarith, Catalin, Aldur, Laconite, Pyralin, Colasta, Textolite, Luxite, Pollopas, Durez, Amerith, Erinoid, Celoron, Aladdinite, Beetle, Karolith, Glyptol, Mowilith N. These materials differ greatly in such properties as color, strength, transparency, molding temperature, shrinkage in molding, tendency to warp or twist, and resistance to decomposition by heat, moisture, acids, or alkalies. Some of them are only to be obtained in the darker shades. Others are completely colorless and transparent. Some may be beautifully tinted, and have been used to produce objects of the highest artistic merit. We shall doubtless see many other new plastics within the next few years, for the classes of chemical substances that lend themselves to chemical synthesis in these directions have by no means been thoroughly explored. Enthusiasts predict that within a few years practically all of our interior finishings, furniture, and office equipment will be fabricated from plastics or from metal supplemented by plastics, to the almost complete exclusion of wood.

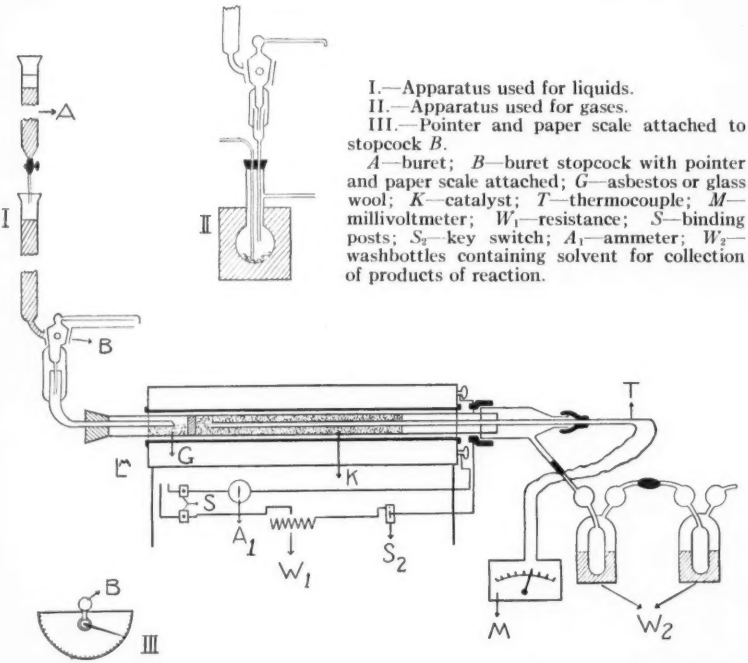
Exhibits of products as distinguished from equipment for carrying out processes were disappointing to the chemical visitor, not merely because they were less numerous than they deserved to be, but because of the air of mystery with which many of them are surrounded. Any really searching question was apt to draw the reply, "Ah, that is a secret." New types of equipment, on the other hand, of necessity disclosed their underlying principles for all the world to see.

Electrothermal Production of Phosphorus. Large-scale production of phosphorus is expected to reach 100 tons daily at the Piesteritz cyanamide works, Germany, where three giant closed three-phase furnaces are used. The crushed rock mixed with quartz and coal are fused, and the volatilized phosphorus converted into acid. The power consumption has been reduced from 11–13 kilowatt-hours to 9 kilowatt-hours per kilo of phosphorus. German phosphorus production (estimated by Dr. Johannes Hess, Munich) is 30,000 metric tons compared to world production estimates, by the same authority, of 33,000 metric tons.—*Chem. Age*, **20**, 446 (May 11, 1929).

ABSTRACTS

APPARATUS AND LABORATORY PRACTICE

Organic Preparations Involving the Use of Catalysts. S. GOLDSCHMIDT AND L. ORTHNER. *Z. angew Chem.*, **42,** 40 (Jan. 12, 1929).—The desire to replace discontinuous reactions with continuous ones, has led to the widespread adoption of catalysts in industrial processes and it therefore seems advisable that even the young students of chemistry be made acquainted with such catalytic preparations. The chief difference between these and the customary routine practice is that they cannot always be carried out according to one set of prescribed directions, the optimum conditions for a continuous process depending on the catalyst, the velocity of the gas stream, the temperature, etc. It is assumed that analytical methods are at hand to control the yield in the individual experiments, and the experimental procedure depends on the desired product so that the time required is no greater than that of the ordinary procedure for which the catalysis is substituted.



I.—Apparatus used for liquids.
II.—Apparatus used for gases.
III.—Pointer and paper scale attached to stopcock *B*.
A—buret; *B*—buret stopcock with pointer and paper scale attached; *G*—asbestos or glass wool; *K*—catalyst; *T*—thermocouple; *M*—millivoltmeter; W_1—resistance; *S*—binding posts; S_2—key switch; A_1—ammeter; W_2—washbottles containing solvent for collection of products of reaction.

1. Apparatus. (*a*) *Electric oven.* This is about 50–60 cm. long and its heating coil is of chrome-nickel wire and is easily made. For temperatures up to 500°, an iron tube is efficient but for higher temperatures it is convenient to use a tube of more heat-resisting material. The interior diameter of the tube is about 2.5 cm. The winding is so arranged that at a temperature of about 500°, a current of 3–4 amperes, and at 500–800°, 6–8 amperes, will flow through the oven. This small current makes the heating take a longer time but makes the use of the oven much less expensive.

(*b*) *Catalysis Chamber.* A glass or iron tube of about 20 mm. inside diameter is used for this purpose, the ends being closed with rubber or cork stoppers. The part of the tube within the oven is filled with the desired amount of catalyst held in place by a plug of glass wool or asbestos. A thermocouple held within a thin glass tube is imbedded in the catalyst.

(*c*) *Measurement of temperature.* For this purpose a simple thermocouple may be used, a millivoltmeter serving to measure the temperature. The thermocouple is calibrated in the usual manner by placing it in substances whose boiling point is known, reading the millivoltmeter, and plotting the temperature against the reading. This is more convenient than a voltmeter with a temperature scale, since the scale belongs only to one particular thermocouple.

For a measurement this thermocouple is placed in its tube. It is not as necessary to know the temperature at any one particular spot as it is to know the temperature gradient within the oven, which is easily determined by moving the couple. It is only in this way that the temperature of the zone reaction may be ascertained, it being often much higher than that of the surrounding medium; a measurement in any other place would give no reproducible values.

(*d*) *Regulation of the velocity of the reaction mixture.* Results sufficiently accurate for routine work may be obtained by simple means.

If the experiment involves a reaction between liquids (*e. g.*, the catalytic dehydration of alcohol), the apparatus shown in Part I of the figure is used. *A* is a buret with a pinchcock and *B* one with a glass stopcock whose tip is drawn out to a fairly small capillary; for fine control of the flow of liquid the stopcock is only partly opened. The cock itself is drawn out at one side and equipped with a pointer and a paper scale (shown in III) so as to allow very delicate adjustment. The buret *A* serves to keep a constant level in *B* and thus maintain a steady velocity of flow. It is best to allow the liquid to flow out over asbestos or glass wool, *G*, so that it is distributed evenly throughout the tube to avoid cracking it.

In the case of gases, the arrangement shown in II is used. The small flask containing some glass wool is heated in an oil-bath to a temperature about 40–50° above the boiling-point of the liquid being used. The velocity of the gas is measured with a flow-meter which must be calibrated for each substance. (An example of this type of reaction is the reduction of nitrobenzene to aniline.)

2. Procedure. The apparatus (whose one end is somewhat raised so as to prevent anything flowing back into the furnace) is first heated and then a measured amount of reagent introduced in a measured time. The reaction products are collected at the right-hand end of the apparatus: if they are liquid, in wash bottles containing a suitable solvent (W_2); if gases, in a gas buret. Aliquot parts are taken from these and analyzed in an appropriate manner. At the beginning of a series of experiments or after changing any of the conditions (*e. g.*, temperature), it is necessary to allow some time to elapse (15–30 minutes) before collecting the products in order to insure complete equilibrium within the reaction chamber. The velocity of the stream of reactants (*i. e.*, the quantity passing through unit cross-sections in unit time) is given by $\frac{\text{quantity passed through}}{\text{time of reaction} \times \text{cross section}}$. For the sake of comparison and reproducibility of results it is necessary, of course, to note for each reaction the cross-section of the tube and the length of the column of catalyst. The factors which may be altered in the course of the experiment are: velocity of reactants, temperature, length of the layer of catalyst, and the nature of the catalyst. If there are several reactants (*e. g.*, in the preparation of aniline from hydrogen and nitrobenzene), the relative quantities of the two in the reaction mixture may, of course, also be changed.

In carrying out a new reaction, a slow constant rate of flow is established, the temperature first changed by large amounts until one is found where the reaction goes on fairly rapidly, and then adjusted carefully until the optimum temperature is found. This temperature is then taken as a standard and the rate of flow changed. These conditions may be determined for the same reaction using different catalysts, etc. The results obtained in this way may be plotted and the deviations and errors very easily recognized.

Examples: 1. ACETONE FROM GLACIAL ACETIC ACID. (D. R. P. 435,347.). Catalyst: iron turnings. Optimum temperature: 530–550°. Diameter of tube: 2 cm. Length of column of catalyst: 45 cm.

Analytical Method: The unchanged acetic acid was titrated with sodium hydroxide and the amount of acetone determined by shaking an aliquot part of the water solution with hydroxylamine hydrochloride. After standing for some time, the hydrochloric acid formed was titrated with *N* NaOH solution with methyl orange as indicator. One cc. *N* NaOH is equivalent to 58 mg. of acetone. Commercial hydroxylamine hydrochloride should be standardized with *N*/10 NaOH and the color of the methyl orange obtained used for comparison. Undecomposed acetic acid does not interfere with the determination of acetone in a dilute solution.

The yield in this reaction was about 86%. The rate of flow and the temperature had a great influence on the reaction.

2. PREPARATION OF ETHYL ACETATE. (D. R. P. 371,691 and 434,279). Catalyst: charcoal obtained by heating wood-shavings with phosphoric acid (sp. gr. 1.3) in a stream of nitrogen; diameter of tube, 2 cm.; length of catalyst layer, 35–40 cm.; equi-molecular mixture of glacial acetic acid and alcohol; optimum temperature, 125°; yield, 90%.

Analytical Method: The unchanged acetic acid was titrated in an aliquot part with *N* NaOH solution, using phenolphthalein as indicator; the end-point is very decisive. The ester formed can also be determined by heating it with a known amount of standard NaOH until completely saponified and then titrating the excess alkali.

Other catalytic esterifications carried out were: methyl acetate (yields up to 95%); isoamyl propionate (yield 75%).

3. ANILINE (D. R. P. 436,820). Catalyst prepared from copper carbonate, lime, and sodium silicate.

Analytical Method: The aniline formed was titrated in methyl alcohol solution with *N* HCl, using phenol-red as indicator.

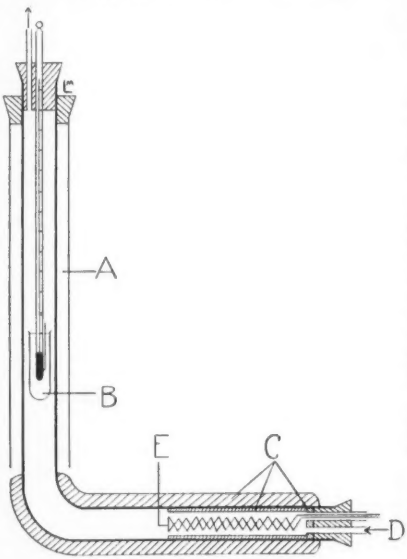
4. ACETALDEHYDE BY DEHYDROGENATION OF ETHYL ALCOHOL (Eng. Patent 262,120, *Chem. Ztrbl.*, **1927,** II, 864, 1619). Catalyst: zinc sulfide at 440°.

Analytical Method: The acetaldehyde formed was determined by means of hydroxylaminehydrochloride as given above for acetone.

5. KETENE FROM ACETONE. Optimum temperature about 650°. Catalyst: clay or silica gel. Layer of catalyst about 40 cm. long.

Analytical Method: The reaction mixture was absorbed in water and the ketene determined as acetic acid. If a mist formed as a result of the condensation, several wash-bottles filled with moist glass-wool were used. The unchanged acetone could also be determined with hydroxylamine hydrochloride as above.

6. ETHYLENE FROM ETHYL ALCOHOL. Catalyst: commercial alumina or freshly precipitated aluminum hydroxide prepared as given by Willstätter and Kraut (*Ber. Dtsch. Chem. Ges.*, **56,** 151); length of layer, 50 cm.; optimum temperature, 400°, yield 90–95% with precipitated alumina.



A—Air jacket, *B*—Oil-bath, *C*—Insulation, *D*—Air stream, *E*—Heating coil.

Analytical Method: The ethylene was determined in the usual manner by shaking with bromine water.

C. E. M.

New Melting-Point Apparatus. F. KERCHOW. *Chem.-Ztg.*, **53,** 219 (Mar. 16, 1929).—The apparatus described allows the direct determination of the corrected melting point. It is a modification of the apparatus described by Hosking and Short, *J. Soc. Chem. Ind.*, **45,** 89T, and involves heating by a stream of air. However, instead of allowing the hot air to impinge directly upon the thermometer, this apparatus has the bulb of the thermometer and the melting-point tube placed in a small oil-bath (the method of suspension of which is not indicated) since only in this way can identity of temperature between the two be maintained. Another modification is the substitution of electrical heating of the air-stream for the gas heating used by Hosking and Short.

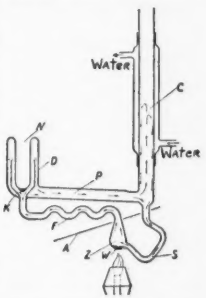
The apparatus consists of a hard glass tube bent at right angles; the horizontal arm contains the heating coil having a resistance of about 7 ohms, and the vertical arm, surrounded with an air-jacket to prevent loss of heat, is long enough to contain the entire stem of the thermometer. A

stream of air enters the lower end of the tube at a constant velocity, is heated by the coil, and in turn heats the oil-bath and the emergent thermometer stem. The heating current, measured by an ammeter, is regulated by an external resistance, so that when the melting point is approached, the temperature may be adjusted to 1 degree in one or 2 minutes.

With a constant current of air of 950 liters per hour, 6 amperes will give 100°C. in 4 minutes and 200°C. in 10; 7 amperes will give 300°C. in 16 minutes. After shutting off the current a further heating occurs: 30° at 100°, 11° at 200° and 5° at 300°C. The current necessary to cause a rise of 1 degree in 1 or 2 minutes is 1.5 amperes at 50°, 2.8 at 100°, 4 at 200°, or 6 at 300°. These data should be determined once for all before using a particular apparatus.

After determining the above data, the melting point is determined in the following simple manner. After adjusting the air current, a heating current of 6–7 amperes is turned on until a temperature is reached which is as much below the conjectured melting point as corresponds to the amount of after-heating. The heating current is then turned off, the after-heating is allowed to continue almost to the end, and then the amount of current for the required temperature rise is turned on. It is convenient to follow the heating with an ordinary thermometer graduated in degrees and then at the inversion point to change to the thermometer, graduated in tenths, which is fastened to the melting-point tube. C. E. M.

A New Ebullioscope for Determining Molecular Weights Using Small Quantities of Substances. E. SUCHARDA AND B. BOBRANSKI. *Przemysl Chem.*, **11**, 371–3 (1927); cf. Swietoslawski, *Roczniki Chem.*, **5**, 96 (1925); *C. A.*, **23**, 2853 (June 20, 1929).—"Liquid (3–5 cc.) enough to fill the reservoir *Z* and the wavy tube *F* up to its outlet to the cup *K* is introduced through the condenser *C*. Enough Hg is introduced into the vessel *N* so that when a thermometer is introduced into it the level of Hg is the same as that of the cup *K*. At the beginning of the determination the jacket *D* and the tubes *P* and *F* are carefully heated with a moving flame; then the solvent in the reservoir *Z* is heated to boiling, best by a microburner provided with a chimney. It should be boiled fast enough to keep up a steady overflow over the cup *K*. Glass powder on the bottom of the reservoir steadies the boiling. After 5–7 minutes the boiling temperature becomes steady to within 0.001°, and at that time the sample (10–50 mg.) may be added through the cooler *C*. The second reading is obtained in 2 or 3 minutes. To avoid the complication of rapidly changing atmospheric pressure two simultaneous boiling-point determinations should be conducted, one with the solvent alone and the other with the solvent and the sample."



C. E. M.

A Convenient Laboratory Distilling Head. *Syn. Org. Chem.*, **2**, No. 5 (June, 1929).—The organic chemist engaged in synthetic work does not ordinarily require a great variety of apparatus, but can make a few flasks and condensers fulfil his needs. There are, however, some additional pieces of glassware, particularly in the line of distillation apparatus, which save much time and make for greater convenience. One of the simplest and most useful of these articles is the distilling head shown in Figure 1. With slight modification it can be assembled with other equipment to form several different types of laboratory distilling apparatus.

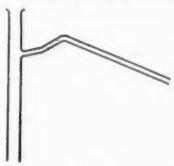


FIGURE 1

Figure 2 shows the distilling head used to convert a short-neck flask to a distilling flask. These heads are particularly useful when applied to flasks of a capacity of two liters or more, and wherever there is danger of breaking the ordinary flask during the distillation. The shoulder shown in the diagram helps to prevent the stopper from being

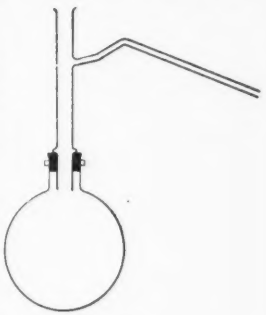


FIGURE 2

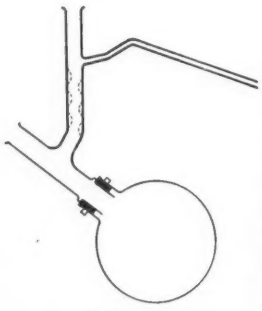


FIGURE 3

sucked into the flask during vacuum distillations.

A Claissen flask can be made very easily by indenting the side wall of the column and sealing it to another tube as illustrated in Figure 3. The opening where the column joins the tube should be larger than the column itself. The inexperienced glass blower will find it easier to make the indentations by heating a spot in the column and sucking in the softened glass into the form of an inside bulb rather than attempting to make them with the end of a file. By tilting the main part of the flask at an angle of 45° there is much less tendency for the side-arm to fill up with the liquid carried by the vapor. In fact, in most cases it is unnecessary to add tile or a piece of capillary tubing to reduce the bumping during vacuum distillations. The humped side-arm nearly eliminates contamination from the stopper unless the distillation is carried on too rapidly.

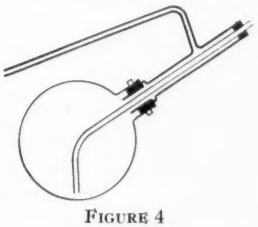
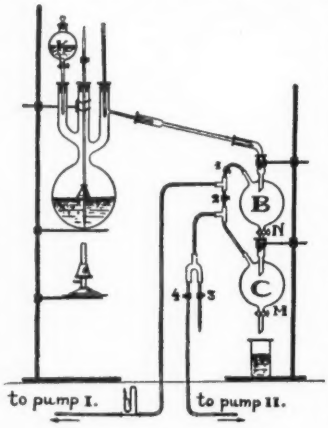


FIGURE 4

The distilling head is easily converted to a steam distillation set-up by adding an inner tubing for the introduction of steam as shown in Figure 4. The length of tube can be adjusted to fit flasks of any size. The ease of fabrication and many uses of this simple piece of glassware make it desirable to have a number of them available in the organic laboratory. G. B. C.

Laboratory Apparatus for Vacuum Distillation. V. M. SEMENOV. *J. Chem. Ind.* (Moscow), **5**, 722 (1928); *C. A.*, **23**, 1780 (April 20, 1929).—"An app. for fractionation *in vacuo* which has the advantages of enabling (1) to conduct uninterrupted distillations, and (2) quickly to attain the needed air rarefaction when dealing with small volume has been designed by S. The distillation flask *A* (see figure) is provided with a capillary tube which regulates the access of air so as to avoid bumping, with a separatory funnel for the introduction of the liquid to be fractionated, and with a thermometer. The receivers *B* and *C* have 2 upper outlets, one of which is connected with a vacuum and the other one serving as a connecting link; the lower outlets are provided with well-ground stopcocks *M* and *N*. 1, 2, 3, and 4 are clamps. The running-water pump *I* gives the system the needed vacuum on condition that 1, 3, and 4 are tightened, 2 is unscrewed, *M* is closed, and *N* open. When a vacuum is obtained and the distillation begins, the first fraction is collected in *C*; by tightening 1 the entry of the liquid into *C* is facilitated. When the second fraction begins to distil, *N* is closed, 1 is unscrewed and 2 is tightened, while air is admitted into *C* through 3, and the first fraction is evacuated through *M*. Then *M* is closed, 3 is tightened, and 4 is unscrewed to open communication with the pump II which gives vacuum to *C*. Then 4 and 1 are tightened, 2 is unscrewed, and *N* is opened (turned on) to permit the passage of the contents of *B* into *C* and so on. New quantities of the substance to be distilled can constantly be introduced through *K* without interrupting the distillation." C. E. M.



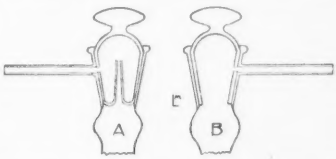
Improvements in the Apparatus of Micro-Dumas. S. OKIDO. *Bull. Inst. Phys. Chem. Res.*, **8**, 25–6 (1929); *C. A.*, **23**, 1530 (April 10, 1929).—"The following improvements are applied to the microchemical N determination: After preheating the combustion tube in a current of air, CO_2 is passed through the tube when it is still red

hot and until it is completely cooled down, the purpose of this being to prevent air being trapped in CuO. A 3-way cock is inserted between the CO_2 generator and the bubble counter, which makes it very convenient to stop the CO_2 current at any time during the analysis." M. W. G.

Device for Carbon and Hydrogen Analysis of Volatile, Explosive, and Easily Carbonizable Organic Liquids. M. C. SEVAG. *Ind. Eng. Chem., Analytical Ed.*, **1**, 16–7

(1929).—This simple device consists of a small pyrex tube containing kieselguhr in which the liquid is absorbed, weighed, and introduced into the combustion tube. Details of procedure and experimental results are included. D. C. L.

An Improved Calcium Chloride Tube. D. V. N. HARDY. *J. Chem. Soc.* (London), **1929,** 1108 (May).—"Calcium chloride tubes of many different designs have been employed for the absorption of water produced during combustions. Of these, the chief types in common usage are: (1) the U-tube with two side-arms, one of which carries a water-trap, and (2) the U-tube similar to that shown in the diagram but having both stopcocks of design *B*. The first type may be used many times with the same filling, but has the disadvantage that, while it is waiting to be weighed, rubber caps must be attached. The use of the second type involves frequent replacement of the filling. The advantages of both patterns are possessed by the U-tube shown (as to its upper part) in the diagram, in which stopcock *A* acts as an efficient water-trap." J. W. H.



Automatic Pipet. O. ORTH. *Chem. Fabrik*, **1928,** 492; *C. A.*, **23,** 1529 (April 10, 1929).—"The pipet has a glass tap at the bottom and is expanded to a bulb at the top. The graduation mark is on the constriction below the bulb and a capillary filling tube ends on a level therewith. The pipet is filled from a wash bottle at a lower level and any surplus runs back. The filling and air release connections are either fused in or taken through a rubber stopper." M. W. G.

Weight Buret. I. ITABASHI. *J. Paints, Pigments, and Printing Ink*, **2,** 107 (1928); *C. A.*, **23,** 1530 (April 10, 1929).—"For weighing out such viscous liquids as varnish, an all-glass apparatus, weighing about 40 g., consists of burets, a conical flask, which also serves as a receiver of the liquid, tube-like stopper and a lid. The capacity is 15 cc. The apparatus may be put on the pan of a chemical balance. Advantage is claimed in its ease of cleaning and in lessening the evaporation of volatile liquid." M. W. G.

Device for the Preparation of Solutions of Constant Density. J. HAMAOUS. *Z. Zuckerind. čechoslovak. Rep.*, **52,** 448 (1928); *C. A.*, **23,** 2854 (June 20, 1929).—"An apparatus for diluting a liquid to constant density consists of a cylindrical vessel containing a float carrying a graduated spindle which, according to its rise or fall, actuates a mechanism controlling the entrance of the diluting liquid at the point where the denser liquid is admitted." M. W. G.

New Apparatus for Electrolytic Analysis. H. J. S. SAND. *Analyst*, **54,** 275–82 (May, 1929).—The apparatus described is based, in general purpose and design, on previously submitted suggestions of the author. The design of the electrodes now submitted, however, is such as to require less platinum.

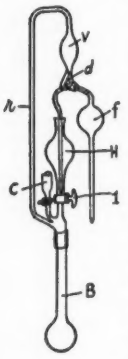
Several types of electrodes, consisting of an inner one surrounded by an outer one, are described in detail. Diagrams showing details of the stirring arrangement and the supports for beakers and electrodes are also included. C. E. M.

A Still for Liquids of High-Boiling Point. K. HICKMAN. *Chem. & Ind.*, **48,** 365–6 (Apr. 12, 1929).—The author describes a form of still adapted for the reduced pressure distillation of unstable organic compounds of high-boiling point. The appa-

ratus is electrically heated, and is constructed so that the vapors have to diffuse only a short distance before reaching the condenser. E. R. W.

A Sublimation Mercury Still. K. HICKMAN. *Chem. & Ind.*, **48**, 366–9 (April 12, 1929).—A description, with illustration, of an easily constructed and operated mercury still. The still has a capacity of about 400 cc. in 24 hrs., equal to about 12 liters a month in constant use. E. R. W.

A New Universal Apparatus for Microanalysis. I. Ashing in a Closed System. E. TSCHOPP. *Biochem. Z.*, **203**, 267–77 (1928); *C. A.*, **23**, 1531 (April 10, 1929).—"Two types of the apparatus are described of which the more simplified model is shown in the figure. It consists of 2 parts: (1) the small flask in which the ashing takes place and (2) the condenser. The ashing mixture (HNO_3, H_2O_2, etc.) is admitted from the cup *c*. The fumes rise through *r* and condense in the bulb *v*, from which the material can either be passed into *f* and thence into a receiving solution, or it may be transferred to *H* by the proper adjustment of the 3-way stopcock *d*. By turning stopcock 1 the substance can be readmitted to the flask. The oxidation is carried out by means of HNO_3 and H_2O_2, but if Cl is to be determined, a measured amount of $AgNO_3$ is also introduced into the flask. The solution is transferred to a 25-cc. flask, made up to vol. with H_2O, and is used for determining Cl, SO_3, P, Na, K, Ca, Mg, Fe, etc. The Cl is determined by titrating back the Ag in an aliquot of the solution. Five cc. of the filtered solution is treated with 5 drops of fuming HNO_3 and 3 cc. of 2% starch and titrated with a standard 0.02 *N* KI to the first blue color. An alternative procedure is to allow the HCl formed in the acid ashing to pass through tube *f* into a flask containing a measured amount of $AgNO_3$. This is continued until no more turbidity is produced when the stopcock *d* is closed and the ashing with $HNO_3 + H_2O_2$ is started. In case the Cl was bound in the combustion flask with $AgNO_3$, it becomes necessary to get rid of Ag before proceeding with other analyses. This is accomplished by adding concentrated HCl and filtering after 20 minutes. P can be determined by any of the colorimetric methods depending upon the reduction of phosphomolybdate. The SO_4 is determined by precipitating with $BaCl_2$ and weighing the precipitate of $BaSO_4$. For details of the procedure consult the test. Ca is determined by the method of Kramer-Tisdall after previously adjusting the reaction. Mg is determined in the filtrate from the CaC_2O_4, the P being measured in the NH_4MgPO_4 precipitate colorimetrically. K is determined by $KMnO_4$ titration (Kramer-Tisdall) after the NH_3 is driven off by boiling with K-free NaOH. For the Na determination the solution is first treated with a little $Bi(NO_3)_3$ and Na-free K_2CO_3 to remove Fe and P, and the Na is precipitated as $6NaNO_2 \cdot 9CsNO_2 \cdot 5Bi(NO_2)_3$, which is determined titrimetrically with 0.1 *N* $KMnO_4$. The solution can also be used for Fe analysis by the Fontes-Thivolle method (*C. A.*, **18**, 92)."



C. E. M.

A New Apparatus for Measuring Hydrogen-Ion Concentrations. P. HANSON. *Dansk Tids. Farm.*, **2**, 139–40 (1928); *C. A.*, **23**, 1532 (April 10, 1929).—"The apparatus described is known as the Wulff's Foil-colorimeter. The working of this apparatus is based on the fact that the H- and OH-ions diffuse into a colloidal membrane much more rapidly than large mols., *e. g.*, indicators diffuse out from such membranes into the surrounding liquid. If now a membrane containing an indicator is placed in a solution not to exceed 2 minutes, its color will indicate the H-ion concentration of the solution. The apparatus is essentially a color scale obtained by mounting on parallel bars transparent strips impregnated with proper indicators and submerged in solutions of known pH values. To make a pH determination a small strip containing the proper indicator is submerged into the solution to be tested for 2 minutes, rinsed with distilled H_2O, and dried between filter papers. It is then mounted on a slider which fits over the parallel bars (like a slider of a slide rule), and its color matched with one of the "standard" strips." C. E. M.

A Cooling Device for a Thermostat. *The Hormone*, **3**, 81 (May-June, 1929).—"Very often in connection with the study of reaction rates, one comes across a reaction which proceeds too fast at or slightly above room temperature. In such cases, it is necessary to run a thermostat at a lower temperature. The ordinary tap water, except in the middle of winter, is usually not cold enough to reduce the temperature of a bath to 10 or 15 degrees Centigrade, consequently some sort of cooling device must be employed. We have experienced this difficulty recently and have solved it as follows.

"We possessed a coiled block tin condenser, such as is used in connection with an

ordinary laboratory still. We packed the container with an ice and salt mixture. Upon circulating tap water through the block tin pipe, and subsequently through about fifteen feet of one-quarter inch copper tubing, made in the form of a coil, which was placed in the thermostat, we have been able to maintain the temperature of our Freas thermostat at fifteen degrees very easily. For our own purposes, this temperature was sufficiently low, but we are reasonably certain that such a device may be employed to obtain and maintain thermostat temperatures of ten and possibly five degrees Centigrade." C. E. M.

A Simple Experiment on Equivalent Weight Determinations. J. E. S. HAN. *Chem.-Analyst*, **17,** 6 (Oct. 1, 1928).—This experiment requires only simple apparatus and little time and is easy to perform. It is well suited for laboratory exercise in general chemistry.

Secure a piece of copper foil. Cleanse it with dilute sulfuric acid and punch a number of holes with a pocket knife. Fill an evaporating dish of about 100 cc. capacity with water and immerse the perforated foil in it.

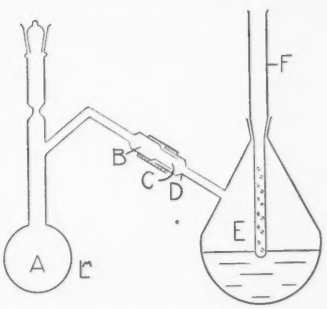
Cleanse one end of a strip of pure zinc metal and cut a small piece weighing about 0.12 gram. Determine its weight accurately. Wrap it up in the perforated copper foil under water, taking care that no air is enclosed.

To 70 cc. of freshly boiled water, while stirring constantly, add gradually 7 cc. of concentrated sulfuric acid (specific gravity 1.84), cool and saturate it with hydrogen. Fill a 50 cc. gas measuring tube with the dilute acid. Close the tube with the forefinger and invert it over the water in the dish. Immediately push the copper foil containing the weighed zinc into the tube and lower down the tube until it touches the bottom of the dish. Hold the tube in position with clamp and stand. Leave alone until all action ceases.

Close the tube with the forefinger and transfer it into a beaker of water. Hold the tube with a clamp and adjust its height so that the surface of the acid inside is on the same level as the water outside. Read the volume of the hydrogen. Record temperature and pressure. Correct the volume of the gas to normal conditions. One cc. of hydrogen under normal conditions weighs 0.00008987 gram. Calculate the equivalent weight of zinc.

Platinum is more suitable for the catalytic agent, but for students' work the cheaper metal can be conveniently used. For very accurate work the impurities in the zinc used should be taken into consideration, and in the calculations the vapor pressure of the dilute sulfuric acid should be used instead of that of pure water. For vapor pressure of sulfuric acid of this dilution see Scott, "Standard Methods of Chemical Analysis," third edition, volume 1, page 609. C. E. M.

The Determination of Available Oxygen by the Bunsen Method. T. W. PARKER AND P. L. ROBINSON. *J. Chem. Soc.*, **1929,** 1106–8 (May).—"The most recent investigation of the accuracy of the Bunsen method of determining available oxygen by liberation of chlorine appears to indicate that results may be as much as 0.5% low (for potassium permanganate) owing to the reaction between chlorine and water [Rupp, *Z. anal. Chem.*, **57,** 2276 (1918)]. Difficulties attending accepted practice, *viz.*, the tendency for the potassium iodide solution to be drawn back into the reaction flask and the necessity of transferring this solution to another vessel for titration [compare Wagner, *Z. anal. Chem.*, **42,** 365 (1903)], have been overcome by using the device shown in the figure.



"The apparatus consists of a 50-cc. flask, *A*, with a ground-in stopper, sealed by sulfuric acid, and a delivery tube of 8 mm. diameter, widened at *B* to 10 mm., the end, *C*, of which is inserted into the especially widened side tube of the absorption flask, rubber being used to complete the joints. The absorption flask, *E*, is a pear-shaped vessel, 18 cm. high and of 250–300 cc. capacity, into the neck of which is fitted, by a ground-joint, the tube *F*, 22 × 2 cm., the rounded bottom of which is pierced with a small hole 8 mm. in diameter. The lower two-thirds of this tube is packed with glass beads. This apparatus is filled to such a height with potassium iodide solution that with the passage of gas the liquid is forced up the tube 1–1.5 inches above the general level before the

pressure is relieved and part of the liquid returns to the main bulk. With such an adjustment there is a continuous interchange of liquid in the bead column, and if for any cause the pressure in the system falls below atmospheric, air passes down the tube into the apparatus.

"In carrying out an estimation 20 cc. of pure concentrated hydrochloric acid were measured into the reaction flask, a fragment of porous pot was added, followed by a small test tube containing a known weight of pure potassium dichromate, after which the stopper was immediately inserted and $^1/_2$–$^2/_3$ of the liquid was gently distilled into the potassium iodide. The absorption flask was then detached, and the bead-packed tube removed after being well washed both inside and outside with potassium iodide solution and with water, and the liberated iodine was titrated with thiosulfate solution. Blank experiments with acid alone showed that there was a constant correction of about 0.45 cc. of 0.04 *N* thiosulfate. The addition of magnesite for the purpose of displacing the last trace of chlorine from the reaction flask was without appreciable effect and the addition of potassium iodide to several lots of diluted residual liquor showed a complete absence of chlorine in all cases. Experiments made in an earlier apparatus, in which the delivery tube was fitted to the neck of the flask by a ground joint, showed that the washing out of this tube does not raise the result. Lubrication of this ground joint with vaseline or with metaphosphoric acid gave slightly low, or higher but somewhat irregular, results, respectively.

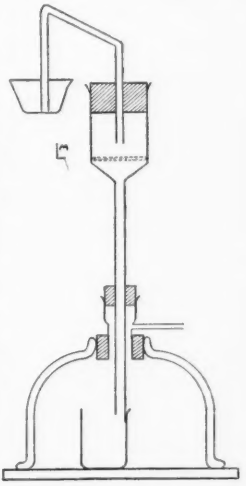
"Ten experiments made with 0.1200 g. 0.2 mg. portions of potassium dichromate and titrated to 0.05 cc. of 0.1 *N* thiosulfate, gave results agreeing among themselves to 1 part in 325 parts, but the mean was about 0.37% low.

"In order to find whether the method was susceptible of a high degree of accuracy a second series of experiments was made in which the dichromate was weighed to 0.02 mg. and the chlorine was liberated under slightly less than atmospheric pressure and absorbed at 0°. The thiosulfate was standardized with 0.1 *N* potassium dichromate by means of a weight buret and an approximately 0.04 *N* thiosulfate solution was prepared by the same method. The weight buret was used for the 0.1 *N* thiosulfate in titrating the liberated iodine, the end-point being finally reached by use of the weaker solution in a buret, and in this manner results to 0.02 cc. of 0.1 *N* thiosulfate were obtained. The following figures, the first being the weight of dichromate (g.) and the second the available oxygen %, indicate a concordance of 1 part in 3250 parts and the mean is 0.18% below the theoretical value: 0.24653, 16.281; 0.24319, 16.283; 0.24681, 16.286; 0.12167, 16.285." J. W. H.

The Absorption of Oxygen by Dilute Alkaline Solutions of Pyrogallol. T. J. DRAKELEY AND H. NICOL. *Chem. & Ind.*, **48**, 62T–64T (Mar. 8, 1929).—It was found that all alkaline solutions of pyrogallol evolved carbon monoxide when used as absorbents for oxygen of high purity. The percentage evolution of CO may be reduced by agitation of the solution during absorption. E. R. W.

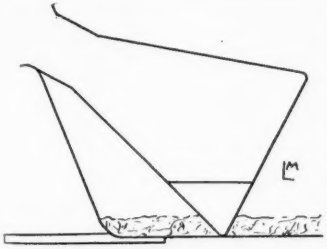
Separation of Lithium from Potassium, Sodium, and Magnesium. L. MOSER AND K. SCHUTT. *Monatsh. Chem.*, **51**, 975–94 (1929); *Analyst*, **54**, 370–1 (June, 1929).—"The accuracy of the published methods was tested, with results given below. *Separation from sodium and potassium.*—The only serviceable methods are those based on the solubility of lithium salts in certain organic solvents; the chlorides of sodium and potassium are too soluble in strong hydrochloric acid for a quantitative separation. Extraction of the mixed chlorides with pyridine, commercial or anhydrous, gives low values for lithium, which can always be detected in the insoluble residue. The method of Winkler (extraction of the chlorides with absolute isobutyl alcohol) was followed with very slight modifications, and proved to give excellent results. Greater care was taken to ensure the complete dehydration of the alcohol, *i. e.*, by three hours' boiling under a reflux condenser with barium oxide and distillation. The two principal changes effected were: (1) the substitution of a sintered glass crucible for a filter paper, as it was ascertained that the paper adsorbs appreciable amounts of lithium salt; (2) siphoning of the lithium extract on to the porous glass crucible instead of pouring the liquid out of the basin. This mode of working obviates the losses due to creeping of the solvent over the edge of the containing vessel. The siphon is worked by suction, its descending member passing through a stopper at the top of a filtration crucible of special construction (see diagram). A deduction of 0.0005 g. is made from the weight of Li_2SO_4 found: this amount is added to the weight of $K_2SO_4 + Na_2SO_4$. Smith and Ross's method (*Analyst*, **1925**, 307)—separation of sodium and lithium perchlorates from the potassium salt by a 1:1 mixture of ethyl acetate and *n*-butyl alcohol and subsequent action of a 20 per cent solution of hydrogen chloride in *n*-butyl alcohol on the soluble perchlorates, sodium chloride being precipitated—was found to give low lithium

results; all the sodium fractions gave strong lithium lines. *Separation from magnesium.*—Conversion of magnesium chloride into the oxide by double evaporation of the solution with yellow mercuric oxide (Berzelius) does not give chlorine-free magnesium oxide. The precipitation of magnesium chloride solutions with alcoholic ammonium carbonate, though quantitative, gave high magnesium results, due to the adsorption of lithia by the magnesium ammonium carbonate, even after double precipitation. The only process of separation that gives correct results is Berg's *o*-hydroxyquinoline method [*Analyst*, **52**, 431 (1927)]. The solution of the chlorides, containing ammonium chloride (80 to 150 cc. bulk), is precipitated at 70°C. with a 2 to 5 per cent alcoholic solution of the reagent till the solution is yellow, the liquid being meanwhile heated to boiling. After cooling, the precipitate is collected on a porous glass crucible, well washed with hot water containing a little ammonia, and dried at 105°C. The filtrate is evaporated in a platinum basin, the residue dissolved in a little dilute hydrochloric acid, and the solution filtered into a tared platinum crucible; the lithium is determined in the usual manner as sulfate. If potassium and sodium are also present, the filtrate from the magnesium precipitate is evaporated to dryness, the residue gently heated for the removal of the ammonium salts, and the lithium in the fixed residue separated from potassium and sodium by isobutyl alcohol." D. C. L.



Microtitration of Iodides in Presence or Absence of Large Proportions of Nitrites. J. F. REITH. *Rec. Trav. Chim. Pays-Bas*, **48**, 386 (Mar. 15, 1929).—As small quantities of iodide ion as 0.5 × (=0.000 g. mg.) may be titrated by using bromine and sulfuric acid. The iodide is oxidized to iodate by bromine in the presence of sulfuric acid, the excess bromine is boiled out and the iodate titrated in the usual manner. The procedure is as follows:

Not more than 1 cc. of the iodide solution is pipetted into a 25-cc. Erlenmeyer flask and acidified by drop-wise addition of 0.5 *N* H_2SO_4, the acidity being determined by streaking methyl orange paper with a platinum wire. About 2 drops excess acid is added, making the pH about 1.6. Three drops of freshly prepared saturated bromine water, enough water to make the total volume 2 cc., and some sifted pumice powder (about 0.5–0.8 mm. in size) are then added, and the flask placed in an inclined position on a sand-bath (shown in diagram). The solution is allowed to boil for 45 seconds after a distinct stream of steam commences and then cooled. The titration is carried out in artificial light such as that from a Philips sun-light lamp, direct radiation from which is avoided.



One-tenth cc. KI solution (=5 mg. KI) is pipetted into the flask, 3 drops of 0.5% starch solution are added and the titration with 0.0001 *N* sodium thiosulfate carried out very slowly. The latter is introduced into the body of the solution by means of a pipet holding from 0.1 to 0.3 cc. and graduated in 0.0001 cc. Near the end-point 0.0002 cc. is added at a time and the end-point determined by a comparison of the color before and after shaking. One cc. of 0.0001 *N* thiosulfate solution determines 21.15*V* of iodide ion, the correction for the sensitivity of the iodine-starch reaction being *V* × 0.10*V* of iodine at 15–18°C., where *V* equals the volume of the solution at the end of the titration. The error in the method is less than 5% with quantities from 0.5 to 1.5*V*, and under 2% from 1.5 to 10*V*.

Bromine water is used as an oxidizing agent instead of chlorine water because small quantities of bromine do not interfere with its action. Chlorine will also oxidize bromine to bromate. For this reason, chlorine could not be used to eliminate error from nitrous acid which, when not completely oxidized to nitric acid, reacts with the iodate formed and causes loss of iodine in the boiling-out process. Sodium azide is a

convenient reagent to use to destroy the nitrous acid. In acid solution the following reaction takes place:

$$HNO_2 + HN_3 \longrightarrow N_2O\uparrow + N_2\uparrow + H_2O$$

no halogen is set free, and since the volatile azoimide is easily boiled off, its slow reaction with iodine causes no error.

The procedure in the presence of nitrite is therefore as follows:

One cc. of the test solution is treated with an excess of 5% sodium azide solution (for 1 mg. HNO_2, 1.7 mg. NaN_3 is used) and the solution acidified with 0.5 *N* H_2SO_4. If nitrites are present, evolution of gas takes place. If the stifling odor of hydrazoic acid is not noticeable, more sodium azide should be added and the acidity of the solution tested. Two drops in excess of the acid and 3 drops of bromine water are then added and the procedure carried out as before. C. E. M.

The Potentiometric Titration of Ammonia. E. B. R. PRIDEAUX. *Chem. & Ind.*, **48,** 87T–88T (April 19, 1929).—Experiments are described, the results of which indicate that the quinone-quinhydrone electrode may be used in the back titration of standard acid in which ammonia has been absorbed. The results obtained agree with those obtained when methyl red was used as an indicator. E. R. W.

A New Test for Boric Acid and Borates. A. S. DODD. *Analyst*, **54,** 282–5 (May, 1929).—The best known test for boric acid is the tumeric test with its modifications. Probably the most delicate test is that with tincture of mimosa flowers [L. Robin, *Analyst*, **29,** 330 (1904)], while for larger quantities the presence of boric acid is indicated by a green flame produced on igniting the substance with methyl or ethyl alcohol and glycerin.

The test proposed, details of which are given in this communication, depends upon a distinctly reddish pink coloration produced by a solution of boric acid in the presence of mannitol and methyl red or Sofnol Indicator No. I.

As a test for borates in mixtures containing salts of various metals and borates, it was found to work very satisfactorily. Phosphates, arsenates, chromates, and tungstates appeared to be the only substances which caused any interference with the distinctness of the reaction. The presence of small quantities of carbonic acid does not cause any appreciable interference with the test if 0.01 g. of boric acid is present. A list of metallic and acid radicals which gave negative results with the test described is given.

The sensitiveness of this test is not quite so great as that with turmeric paper. The latter is stated (Treadwell and Hall, Vol. 1, p. 359) to give a distinctly visible reaction with 0.2 mg. of B_2O_3, whereas this test was found to give a distinctly visible reaction with 0.2 mg., and a very distinct reaction with 0.3 mg. of boric acid (H_3BO_3) in 10 cc.

The sensitiveness is increased by concentration, and 0.0004 mg. of boric acid in 2 drops of liquid was found to give a visible reaction.

Glycerin or invert sugar may be used in place of mannitol, but the reaction is not quite so distinct with small quantities of boric acid. Glycerin was found to give a visible reaction with 0.3 mg. of boric acid in 10 cc. of solution. C. E. M.

The Determination of Small Quantities of Beryllium in Rocks. B. E. DIXON. *Analyst*, **54,** 268–74 (May, 1929).—There is considerable evidence that titanium in addition to aluminum will be present in appreciable quantities in rocks containing small quantities of beryllium. It is the titanium which is the chief obstacle to the accurate determination of small amounts of beryllium in these rocks. Satisfactory methods have been worked out for separating beryllium and aluminum. On the other hand, several proposed methods for separating beryllium and titanium are outlined and shown to be unsatisfactory.

The method proposed makes use of the organic base, *p*-chloroaniline. This base seems to be sufficiently weak to avoid causing any precipitation of the beryllium, but strong enough to precipitate completely the very weak hydroxide of titanium.

The proposed method is outlined in detail and accompanied by a table containing results of 15 analyses. The error in BeO and TiO_2 actually obtained is of the order of 0.0002 g.

The superiority of this method over the phenylhydrazine and the tannic acid methods is shown. Details are also included for a method of analysis of a silicate rock with especial reference to the accurate estimation of beryllium in small quantities. C. E. M.

Determination of Zinc Oxide in Paints. E. J. DAVIS. *Chem. News*, **138,** 394 (June 21, 1929).—"The following method, devised by the writer, is the only method of estimating ZnO accurately in the presence of lithopone ($ZnS{\cdot}BaSO_4$). Besides being accurate the method is rapid and simple, the old method being more tedious

and giving very doubtful results. Because of the frequency of occurrence of ZnO with lithopone in paints, the method is of no small practical importance. Besides the ZnO-lithopone combination, the ZnO may be estimated equally as well in all other combinations of paint.

"The method depends on the solubility of ZnO in a fairly concentrated solution of NH_4Cl in the presence of NH_4OS. All other paint pigments are insoluble in this solution.

"Take a 1 g. sample of suitably extracted pigment, and then add 50 cc. of a saturated solution of NH_4Cl, together with 35 cc. of concentrated NH_4OH. Boil five minutes and filter. After washing with hot water containing NH_4Cl, test the residue on the filter paper for Zn, and if none is present, dilute the filtrate and washings to 400 cc. Acidify and titrate with ferrocyanide as directed under the ordinary volumetric procedure for zinc.

"The entire determination may be run in 20 minutes, whereas the old method required waiting over night for results. The method has been repeatedly checked and found accurate to within 0.1 per cent." C. E. M.

A Simple Method for the Determination of Acetaldehyde. Y. TOMODA. *Chem. & Ind.*, **48**, 76T–77T (April 5, 1929).—"A known volume of an aqueous solution of acetaldehyde is mixed with a slight excess of sodium or potassium bisulfite solution, and kept for 15 minutes. A few drops of starch solution are added and 0.1 *N* iodine solution is run in drop by drop until a blue color is just produced. Sodium bicarbonate is carefully added until there is an excess of the solid bicarbonate." When the blue color disappears the mixture is titrated with 0.1 *N* iodine, which gives the amount of combined sulfite and which is equivalent to the amount of acetaldehyde present. E. R. W.

Determination of Alcohol in the Presence of Acetaldehyde. Y. TOMODA. *Chem. & Ind.*, **48**, 77T–79T (April 5, 1929).—The alcohol is removed from the solution by aeration at room temperature. Apparatus for this is described. A large excess of sodium bisulfite completely prevents the volatilization of the acetaldehyde. The alcohol is oxidized to acetic acid with potassium dichromate and sulfuric acid, distilled and titrated with barium hydroxide. E. R. W.

The Removal of Thiophen from Benzene and a New Method for the Preparation of Thiophen-Free Benzene on a Laboratory Scale. E. G. R. ARDAGH AND C. M. FURBER. *Chem. & Ind.*, **48**, 73T–76T (April 5, 1929).—Red mercuric oxide and stearic acid were added to the benzene, the mixture was heated for a short time on a water-bath, and distilled. The distillate was found to be free from thiophen. A component of mercuric oxide-thiophen and stearic acid is probably formed which is not decomposed at the boiling point of benzene. Several other methods are mentioned. A list of about 50 references is given. E. R. W.

Barium Sulfate as an Indicator of the Efficiency of Sulfuric Acid in Drying Apparatus. G. BOEHM. *Chem.-Ztg.*, **53**, 323 (April 24, 1929).—Sulfuric acid retains its desiccating properties until it has been completely converted into the dihydrate, $H_2SO_4 \cdot 2H_2O$ (84.48% H_2SO_4) which has a vapor tension of 0.131 mm. at 15°, whereas the vapor tension of the trihydrate is 0.681 mm. Barium sulfate serves very well to detect the formation of the dihydrate when about 18 g. of it are added to a liter of sulfuric acid. Until about $^1/_2$ the amount of water required to give the dihydrate has been absorbed, the acid remains entirely unchanged. On further dilution, $BaSO_4 \cdot 2H_2SO_4 \cdot H_2O$ is precipitated out in bundles of needle-like crystals which render the acid pasty. These, however, are not stable, but, when more water is taken up, are transformed into fine powder-like crystals of barium sulfate. If the absorption of water is so fast as not to allow the formation of acicular crystals, the end-result is nevertheless the same at a concentration of 84%, fine crystals of $BaSO_4$ forming on very slight shaking. Therefore, if there are still acicular crystals in the acid, it need not be changed, but when the precipitate is fine and granular the acid has lost its effectiveness as a drying agent. It is advisable to use the purest barium sulfate and to dissolve the required amount in a small volume of acid at 100°C. and then to add the rest of the acid. C. E. M.

Hints on Filtration in Organic Preparations. *Syn. Org. Chem.*, **1**, No. 3 (Feb., 1928).—"In organic preparative work by far the majority of filtration operations are carried out with the aid of suction. When only small amounts of material are in treatment, filtration of recrystallization solutions may be advantageously effected with folded papers, but for volumes of a liter or more the use of suction will generally be found preferable. In such a case the funnel should be warmed before use; this is conveniently done by attaching it in the usual way to a filtering flask and passing steam into it from below. A rapid current of air is sufficient to dry it while still warm.

Or the funnel may be warmed by stoppering it to a flask in which the appropriate solvent is vigorously boiling.

"Crystals are always collected in a suction funnel, fitted with a hardened paper from which the product can be removed without danger of contamination with cellulose fibers. For small amounts—particularly when relatively large volumes of mother liquor are present—the conical Hirsch suction funnel is preferable to the Büchner type.

"Suction funnels of all laboratory varieties possess stems which are too short for convenient use with conical suction flasks, the filtrate often having an annoying tendency to froth or splash from the funnel into the side arm. This defect may be remedied by attaching to the stem of the funnel a wide rubber tube long enough to discharge the filtrate well below the level of the side tube.

"A preferable alternative is to replace the customary filtration flask by a stout, wide-mouthed bottle or, even better, a round-bottomed flask. Suction is applied through a right-angled tube inserted in the stopper attaching the funnel. This scheme works satisfactorily with pyrex flasks of from three to twelve liters' capacity, and with funnels up to about fifteen centimeters in diameter. For larger apparatus it is advisable to support the funnel on a tripod and to connect it by means of a suitable adapter (stoppered to the stem of the funnel) and glass tubing joined with pressure tubing to the receiving flask.

"When very large quantities are to be filtered, a different and highly unorthodox method may be found useful. The funnel is fitted with an adapter to which is attached a pressure tube leading to the receiving flask. The filter paper is moistened and placed in position, and suction applied. The funnel is then allowed to hang upside down in the mixture to be filtered; it may either be lowered gradually so as first to draw off the supernatant liquid or at once placed near the bottom of the container, so that the solids collect around it and form their own filtering mat. In the latter case, which is especially applicable to the case of readily filterable mixtures containing large bulks of solid, the filter cake can be washed without removing the funnel.

"Slimy solids, which first pass the filter and then clog it, cannot be satisfactorily collected with suction. The ordinary conical paper filter of the inorganic chemist is less efficient than a flat filter paper laid on a Büchner funnel: as soon as the filtrate comes through clear, the first runnings are returned to the funnel and the filtration is carried out entirely by gravity. The cake can then be washed in the same way.

"The use of a thin rubber sheet for pressing out finely divided solids, as recommended by Gortner [*J. Am. Chem. Soc.*, **36**, 1967 (1914)], is often of great value. It is especially applicable in the case of precipitates which tend to "channel" or crack when approaching dryness. [See THIS JOURNAL, **6**, 160 (Jan., 1929).]

"Large quantities of mixtures to be filtered are conveniently transferred from container to filter by means of a cup and saucer of heavy china. The saucer is employed to prevent material from dropping from the cup during transference and to keep the cup from contact with laboratory table." G. B. C.

Extending the Life of Chemical Glassware. J. T. LITTLETON, JR., AND G. A. DASNEY. *Ind. Eng. Chem.*, **19**, 1271 (Nov., 1927).—"There have been undoubted improvements in chemical glassware in recent years, particularly with regard to its ability to resist heat and mechanical shocks. However, the user is inclined to push his apparatus to the limit and because of such severe service the improved quality may not be evident.

"Glass is broken by both mechanical and thermal shocks. The simplest way of improving mechanical strength is to increase thickness, and unfortunately this lessens the ability to withstand temperature changes. The manufacturer accordingly sets his standards for thickness to what he believes the service demands. If the service requires resistance to temperature change the article is made with a minimum wall thickness consistent with suitable mechanical strength. If, however, the service is largely mechanical, heavier walls are provided. A filter flask is made with heavier walls than a distillation flask.

"It is evident, then, that the article should be used in the service for which it is designed. Heavy ware should not be subjected to the extreme degrees of heat service which light ware will stand and light ware should be protected from mechanical abuse.

"Chemical glass from all sources is as a rule well annealed when shipped from the factory, but if the glass is good it can be strained in service. Certain glasses break outright when cooled after overheating, while others merely take on strain. The type of strain introduced in service is particularly dangerous, as it is located at a point on the vessel where the conditions are most severe and is usually of an intense nature (Figure 1). The broken circles of light show where a flame has been applied of such

intensity as to soften the glass slightly and thus produce permanent strain. If the contents of a flask are evaporated to dryness over a flame, or if an intense pointed flame is used under a flask containing liquid, such strains can be introduced. Breakage may take place, not at the time the strain is caused, but later in conditions of very moderate service, leading the user to believe that the glass was of poor quality. However, had it not been of good quality it would not have withstood the conditions causing the strain. The better grades of chemical glassware cannot be strained in service until they are above 500°C. Permanent strains are introduced in service with surprising frequency, and are evidence that the glass has been subjected to temperatures higher than required for ordinary laboratory manipulations.

"Such operations as evaporating to dryness over a flame should therefore be carried out with care and the vessel should be removed from the flame before the heating has been excessive. A sharp-pointed, intense flame should be avoided. Large, slow flames uniformly heating the vessel are safe and will not introduce strain as long as the vessel contains water solutions.

"It is well known that sharp scratches and abrasions in a glass surface are a cause of fragility. Glass tubing and rods are easily broken when marked by a file. Exactly the same condition results when a beaker or flask is scratched. Scratches on the inner surface are particularly dangerous. This is readily seen by analyzing the stresses introduced while in service. If a beaker containing water is heated the hotter outer surface tends to stretch the inner surface. A scratch on a surface in tension increases the stresses at the sharp angle at the bottom of the scratch and fracture is more liable to occur. A scratch also makes the vessel more subject to mechanical breakage. The user of chemical glassware is therefore cautioned to avoid scratching or abrading the surface of the ware in cleaning, scraping, and stirring the contents of the vessel."

D. C. L.

Collapsing Temperature of Various Kinds of Laboratory Glass Tubing. A. W. LAUBENGAYER. *Ind. Eng. Chem.*, **21,** 174 (Feb., 1929).—Tubes with a bore of 13 mm. and a wall thickness of 1.8 mm. were used. Tests, carried out to duplicate as nearly as possible the conditions under which glass is ordinarily used, were of two types: (1) A tube open at both ends was heated in an ordinary electric tube furnace; the temperature was quickly raised to 300° and then at the rate of 3° per min. until the tube collapsed. (2) A tube was sealed at one end, evacuated to 3 mm. pressure, and heated until the tube collapsed. Results were as follows:

Glass	*Open tube*	*Evacuated Tube*
Soft soda-lime (Greiner-Friedrichs)	700	585
"R" (resistance glass, G. & F.)	750	635
Pyrex	820	670
Jena combustion tubing	860	720
Bohemian combustion tubing	860	740
Moncrieff combustion tubing	820	770*

D. C. L.

* This glass devitrified readily.

Films Showing Glass-Blowing Technic. *Syn. Org. Chem.*, **2,** No 4 (May, 1929).—Two short reels showing the most common operations in laboratory glass blowing have been made in the Kodak Research Laboratories. These have been printed on 16-mm. safety film and incorporated in the program of the Eastman Teaching Films, Inc., an organization formed last year to produce educational motion pictures. The different operations in elementary glass blowing are demonstrated by an expert showing the simplest method in each case. All of the demonstrations are carried out with pyrex glass on account of its adoption by most of the laboratories in the country.

One of the first scenes shows a typical glass-blowing bench with the equipment usually found in the average laboratory. The few tools required are shown as they become necessary for the work. The correct way of cutting glass tubing is demonstrated, using either a glass knife or a hot wire. Other operations included in the first reel are the bending of glass tubing, making test tubes and T tubes, and repairing

a distilling flask. An illustration, taken from the second reel, shows the finishing touches in sealing a bulb to a narrow tube.

"Glass Blowing Technic" can be shown to a class in the laboratory or lecture room, and will be found of real assistance in learning the proper technic. Price $35. These films are obtainable only from Eastman Teaching Films, Inc., 343 State Street, Rochester, N. Y. G. B. C.

Improving "Slide-Rule Accuracy." *Chem. & Met. Eng.*, **36,** 369 (June, 1929).—"Every engineer who has much use for a slide rule has evolved some method for keeping track of the decimal points, only to find that the system is likely to fall down at a critical juncture. William J. Alcott, Jr., writing recently in *Engineering News-Record*, gives a system of "one-place" logarithms which the writer says not only fixes the decimal point in complicated calculations but also provides a rough check on the accuracy of the slide-rule computation.

"The mantissas given are as follows:

Number	*Memory Mantissa*	*Two-Place Mantissa*
1.3	0.1	0.11
1.6	0.2	0.20
2	0.3	0.30
3	0.5	0.48
4	0.6	0.60
5	0.7	0.70
6	0.8	0.78
7	0.85	0.85
8	0.9	0.90
9	0.95	0.95
10	1.0	1.00

"A brief glance at a log table will convince the reader of their accuracy. For use, the "memory mantissas" should be memorized according to the following scheme: The mantissas 0.1 and 0.2 correspond to the numbers 1.3 and 1.6 which are spaced approximately evenly between the numbers 1 and 2. The mantissa for 2 is 0.3. Then for numbers 3 through 6, the mantissas are two more than the number—that is, for 3, 0.5; for 4, 0.6; for 5, 0.7; and for 6, 0.8. Then for the numbers 7 through 9, the mantissas increase by steps of half-tenths; thus the mantissa for 7 is 0.85; for 8 is 0.90 and for 9 is 0.95.

"The column of mantissas for two places is added for comparison, although for purposes of rough check and pointing off, it is not necessary to memorize its variations from the single-place figures.

"The "one-place" logarithms are used just as ordinary log tables are used. That is, when each is assigned its proper characteristic, it may be added or subtracted, multiplied or divided. The result will give the number of decimal places accurately, while the slide rule is used to obtain the significant figures." G. B. C.

Weighing Systems as Illustrated by Modern Scales. KARSTEN. *Chem. Fabrik*, **1929,** 3–5.—A description of modern (German) commercial varieties of platform scales, etc. C. E. M.

TEACHING METHODS, AIDS, AND SUGGESTIONS

The Conduct of Courses in Teaching of High-School Chemistry. J. O. FRANK. *Sci. Educ.* (formerly *Gen. Sci. Q.*), **13,** 211–6 (May, 1929).—On account of having been called upon by various individuals to prepare plans for conducting courses in chemistry, the author here presents a plan which ought to be of interest to both teacher and pupil. The plan may be adopted to the teaching of biology, physics, and general science as well as of chemistry. Reference is made to earlier papers in the March (1928) issues of *Gen. Sci. Q.* and THIS JOURNAL. In planning any course, in addition to well-defined ultimate objectives, the instructor should have in mind a very large number of smaller, more easily understood and more concrete goals which might be called intermediate objectives, and which if successfully accomplished would make certain the realization of the larger and more abstract ultimate objectives. The aims of the course in terms of the *activities* necessary to accomplish them should be thought of. The author supplements his statements with a list of instructor's *activities*, one of students *activities*, and one of factors affecting the success of a course in the teaching of any science. J. H. G.

Dull Teaching Handicaps Science Teaching. J. L. TILDSLEY. *School*, **40**, 666 (May 30, 1929).—"For every boy or girl studying in any field of science today, there are two studying a foreign language in New York City's high schools." May this not be " due to the insistence of. . . . teachers on continuing to deal with science as an abstract subject instead of an intensely human subject?" There is a need "for more imagination and less formalism in the handling of science in the schools." Preferences expressed by several thousand New York City high-school pupils gave biology first place, chemistry second, and physics third.

"The method of science is the method of higher living. Its great leaders have been men of imagination, men of vision. . . . and with devotion for the truth." High-school science teachers need to emulate such leaders. B. C. H.

KEEPING UP WITH CHEMISTRY

General Principles of Stain Remover. H. F. EHLER. *Neo-Chemto-Ion*, **3**, 19–22 (May, 1929).—The subject of stain removal is considered under three heads: (1) the nature of the stain, (2) the nature of the material stained, and (3) the actual treatment of the stain.

Mr. Ehler is the author of a very fine pamphlet, "Century Anti-Stain Formulary," which can be obtained from him at Hughes High School, Cincinnati, Ohio, at a very nominal cost. Through a very ingenious device of listing by number the names of stain removers in one table, followed by a table listing the stain, and the number of the appropriate stain remover for linen, cotton, silk, and wool, respectively, in proper columns, Mr. Ehler has been able to list 26 stain removers and 85 different types of stains in the short space of three pages. Other valuable information regarding stains and stain removers is to be found. G. B. C.

Synthetic Chemicals as Indicators. *Syn. Org. Chem.*, **2**, No. 4 (May, 1929).—The first organic compounds which were observed to show color changes at different degrees of acidity were probably of vegetable or animal origin. Most of these, however, such as alizarin, cochineal, turmeric, etc., are rapidly disappearing from the laboratory shelf. An exception is litmus, which, in the form of an indicator paper, is still valuable for comparatively rough determinations of acidity. Practically all of the indicators used today are synthetic products made either in organic laboratories or dye plants.

The mechanism of the color change in indicators, all of which behave as very weak acids or bases, is still somewhat obscure. Ostwald suggested that the two colors are due to the ionization of the indicator at different hydrogen-ion concentrations—the ionized form being a different color from the undissociated molecule. Later evidence has shown that in addition to ionization, there is an internal rearrangement of the molecule which is largely responsible for the changed color. The lack of knowledge regarding the cause of the color transformation has not prevented the extensive use of these compounds as valuable laboratory reagents. In fact, the number of indicators recommended became unnecessarily large, and in 1909, S. P. L. Sorensen, of the Carlsberg Laboratory, in connection with his work on enzymes, investigated the available indicators and chose a series the members of which were especially suitable for biochemical work. Since that time other series of indicators have been selected which cover a wide range of pH values.

By far the largest number of indicators are found in the azo dyestuffs. These include Methyl Orange (dimethylaminoazobenzene sulfonic acid), Methyl Red (dimethylaminoazobenzene carboxylic acid), and many other valuable indicators such as Neutral Red, Methyl Yellow, Orange I, Alizarin Yellow R, etc. The pararosaniline dyes, which include Crystal Violet, Methyl Green, Ethyl Violet, and Fuchsin, also are often used as indicators.

The phthaleins as a group have been found to be excellent indicators for the alkaline region. In addition to phenolphthalein and tetrabromophenolphthalein, the cresol-, naphthol-, xylenol- and thymol-phthaleins make useful indicators. The color changes of this group are somewhat unusual when compared with other indicators. All of these phthaleins are either colorless or faintly yellow and have a lactone formation in acid solution. As alkali is added the lactone structure changes to a quinoid form which is brightly colored. With further excessive addition of alkali, a salt of a carboxylic acid carbinol which has no quinoid structure is formed, so that the solution becomes colorless again.

The sulfonphthaleins were studied by Clark and Lubs, who prepared a series of indicators composed entirely of compounds in this group. Owing to their brilliant colors, they have been found especially useful for the colorimetric determinations of hydrogen-ion concentrations. They are made by condensing phenolic compounds

with the anhydride of *o*-sulfobenzoic acid in the presence of zinc chloride. The following table of sulfonphthaleins shows the pH ranges and abbreviated names for some of this group.

Sulfonphthalein Compound	*pH Range*
p-xylenol-(Xylenol Blue)	1.2–2.8
tetrabromophenol-(Brom Phenol Blue)	3.0–4.6
tetrabromocresol-(Brom Cresol Blue)	4.0–5.6
dibromocresol-(Brom Cresol Purple)	5.2–6.8
dibromothymol-(Brom Thymol Blue)	6.0–7.6
phenol-(Phenol Red)	6.8–8.4
o-cresol-(Cresol Red)	7.2–8.8
thymol-(Thymol Blue)	8.0–9.6

Another series of indicators suggested by Michaelis is composed of a group of nitrophenols. The range of color changes, which in each case is from colorless to yellow, is shown in the accompanying table.

Nitrophenol	*pH Range*
2,4,6-Trinitrophenol	0.0–1.3
2,6-Dinitrophenol	1.7–4.4
2,4-Dinitrophenol	2.0–4.7
2,5-Dinitrophenol	4.0–6.0
p-Nitrophenol	5.0–7.6
m-Nitrophenol	6.5–8.5

In acidimetry and alkalimetry, the choice of indicator for a given titration depends on the concentration of hydrogen ions furnished by the resulting salt. If a slightly alkaline salt like sodium acetate is formed at the equivalence point, an indicator should be used which will show a change in color on the alkaline side. Phenolphthalein or Thymol Blue, which change color at a pH of about 8–10 should, therefore, be used in titrating acetic acid with sodium hydroxide. If a weak base like ammonia is being titrated with a strong acid, the resulting acid-reacting salt will require that the indicator change color on the acid side of neutrality. In this case, either Methyl Red or Brom Cresol Blue, which change at a pH of about 4–6, could be used. When a highly ionized neutral salt is formed, as in the case of titrating a strong acid with a strong base, a slight excess of either solution makes a large change in hydrogen-ion concentration, so that any indicator having a color change between pH 3 and 11 would be satisfactory. Conversely, the titration of a very weak base with a weak acid is seldom significant owing to the relatively small change in pH value at the end-point.

An important application which evolved from the study of indicators is the direct colorimetric determination of hydrogen-ion concentration. One of the simplest methods consists in adding an indicator to the unknown solution, and comparing the tint with a series of reference solutions which contain the same indicator but vary in hydrogen-ion concentration. These standard reference solutions are buffered to definite pH values by mixtures such as borax and boric acid, sodium acetate and acetic acid, or sodium hydroxide and potassium acid phthalate. The amounts of the components to use have been carefully worked out and the actual pH may be checked by hydrogen electrode measurements. These colorimetric methods have found many industrial applications, among which are the control of water purification, sizing of paper, sewage disposal, sugar refining, baking, tanning, electroplating, etc.

As in all quantitative methods, each new application requires an investigation of the conditions involved. Such factors as the color range of the indicator, its concentration, and the effect of salts, proteins, etc., on the indicator itself must be considered. Much of the information regarding the various indicators is already available and more knowledge concerning them is added each year. G. B. C.

Cellulose Acetate Solvents. *Syn. Org. Chem.*, **2,** No. 5 (June, 1929).—A short account of the general solubility properties of the very interesting colloidal material, cellulose acetate. G. B. C.

The Toxic Property of Sulfur. R. C. WILLIAMS AND H. C. YOUNG. *Ind. Eng. Chem.*, **21,** 359 (April, 1929).—Ordinary pure commercial sulfur used for fungicidal purposes has associated with it sulfurous, sulfuric, and pentathionic acids. Of the acids usually associated with sulfur, the most toxic to certain types of spores are the polythionic acids. When freed from this type of acid the sulfur was not toxic. The filtrate from sulfur which has been thoroughly wet owes most of its acidity to sulfuric acid.

Sulfurous acid is present in only very small amounts, and appears to be an intermediate product. A solution of sulfuric acid having the same total acidity as the filtrate was not found to be toxic. Artificially oxidized sulfur was found to be very effective except where the oxidizing agent was strong enough to destroy the polythionic acids. Lime sulfur sprays were found to lose their alkalinity when exposed to sunlight and air although not when retained in a closed flask. The toxicity becomes noticeable only when the medium is acid, probably because the spore tissues are amphoteric in nature, a condition found in proteins and also in agar, a carbohydrate, the effect of the anion becoming marked on the acid side. D. C. L.

Sulfonated Oxidation Products of Petroleum as Insecticide Activators. M. J. INMAN, JR. *Ind. Eng. Chem.*, **21**, 542 (June, 1929).—The search for cheaper and more effective methods of controlling insect pests has given the chemist an enticing problem. This article points out the essentials of a good spray and shows how, by the use of 0.5% of this sulfonated oxidation product of petroleum in place of soap as a spreader, the amount of nicotine sulfate necessary can be reduced to one-fifth. D. C. L.

Colored Luminous Steam. L. C. PORTER, G. F. PRIDEAUX, AND W. H. STEIGER, *Gen. Elec. Rev.*, **32**, 284–7 (May, 1929).—A very complete description of the principal feature of decorative lighting used last Christmas at the Edison Lamp Works at Harrison, (N. J.). Batteries of floodlight projectors having colored cover glasses were trained on a jet of steam escaping from the top of a 125-ft. stack. Very beautiful effects were obtained at night using various combinations of color.

An effective and spectacular form of advertisement is made available by the use of colored luminous steam. Suggestions for the best type of installation and operation are given. H. T. B.

Conductivity and Hydrogen-Ion Measurements. W. N. GREER. *Instruments*, **2**, 209–12 (June, 1929).—Paper read before Students' Course at Twelfth Exposition of Chemical Industries. The paper indicates how electrometric equipment may be used as a means of studying, and even controlling, various processes in the pulp and paper industry. G. B. C.

Lead Pigments Produced Direct from Galena Ore. *Oil, Paint & Drug Reporter*, **1929**, 29 (June 3).—White lead (lead carbonate) and chrome yellow (lead chromate) are being made direct from galena ore by continuous chemical processes in the experimental plant of the General Reduction & Chemical Company, 225 Murray Street, Newark, N. J. Small commercial production is being carried on, the plant being one in which the equipment was originally installed to adapt laboratory processes. Demonstrations given in the past week show that operation on a commercial scale has been perfected.

The processes employed by the General Reduction & Chemical Company are those discovered by Dr. George E. Kingsley. The basic process, which is covered by patent, is that of dissolving the minerals out of galena ore with the aid of nitric acid, without oxidation of the sulfur. This eliminates the troublesome fumes which attend the smelting process. The second step, a secret process, consists in separating the lead, iron, zinc, silica, silver, and other constituents of the ore. It is the claim of the discoverer that the working solution contains lead in a state of very high purity, without even a trace of iron. On this claim is based the company's statement that its white lead is really white and that it will remain so. Separation of each of the other constituents of the ore in a pure state is claimed to be commercially practicable.

To prepare white lead the nitric acid solution of the lead from the ore is precipitated with soda carbonate (soda ash or sal soda). To prepare chrome yellow it is precipitated with sodium bichromate. A basic sulfate white lead can be made by precipitating the solution with sodium sulfate (Glauber's salt). The precipitates are very finely divided. They are collected in the usual manner with filter presses and drying apparatus and ground.

It is claimed for the Kingsley process that it reduces waste to a minimum, thereby increasing the original saving due to the elimination of smelting. The sodium nitrate resulting from the reaction of the precipitants on the nitric acid solution of lead can be converted into nitric acid. The excess of nitrogen oxides is treated in special apparatus to produce acid. Zinc separated from the ore is converted into zinc oxide. The iron is used for making a compound blue pigment with a lead carbonate base, or it can be employed for making Prussian blue and chrome green.

The sulfur content of the ore is removed as an amorphous form of the element, which is used or sold for the manufacture of sulfuric acid. The silica is recovered in a finely divided state, said to be specially adapted for making mosaic tiles. C. E. M.

The Trona Enterprise—Recovery of Potash and Borax. G. R. ROBERTSON. *Ind. Eng. Chem.*, **21,** 520 (June, 1929).—"Dedicated to the memory of Willard Gibbs" is suggested as an appropriate lettering for the corner-stone of this plant, because of the large part phase rule diagrams have played in the problem of recovering potash and borax from the complex mixtures present in Searles Lake. The article gives a description of the processes used and the difficulties involved in arriving at the present production of 240 tons potassium chloride, 130 tons borax, and 10 tons boric acid per day while 1500 tons of worthless salts are thrown back into the same lake. D. C. L.

Basic Industrial Minerals: No. 7. Leucite. G. M. DYSON. *Chem. Age*, **20,** 472–3 (May 18, 1929).—Leucite, one of the complex silicates, may be profitably worked for either potassium aluminum sulfate or potassium chloride. When treated with sulfuric acid in the preparation of alum, the siliceous skeleton does not disintegrate into a gelatinous mass, but remains intact and easily filterable. It may be that in the future our potash and aluminum will be obtained from granitic rocks. E. R. W.

Rayon: Growth and Development of a Great Industry. A. B. SHEARER. *Chem. Age*, **20,** 35–6 (May 11, 1929).—The tendency to refer to rayon as "artificial silk" is unfortunate in that it tends to foster an erroneous impression of inferiority. Rayon yarns as fine as the finest silk are now produced on a commercial scale, while some fibers have been made which are so fine that over 5000 miles would be needed to weigh one pound. A brief description of the four leading processes is given. E. R. W.

Weighting Silk. ANON. *Silicate P's & Q's*, **9** (June, 1929).—The "taking up" of mineral matter by the silk fiber, known as "weighting," improves the appearance of both the natural and dyed fiber. Moderate weighting does not materially affect the tensile strength, aging, and elasticity.

Much research work in the silk industry remains to be carried out. H. T. B.

The Lithopone Industry. W. BANNARD. *Chem. & Ind.*, **48,** 335–8 (April 5, 1929).—Lithopone is a white pigment consisting of a mixture of zinc sulfide and barium sulfate. Technical methods of preparation are given. Cadmium lithopone, a pigment made up of cadmium sulfide and barium sulfate, having a rich yellow color, may be of considerable importance in the future. E. R. W.

Deconcentration: An Aspect of Boiler Control. ANON. *Chem. Age, Part 1*, **20,** 443–4 (May 11, 1929); *Part 2*, **20,** 465–6 (May 18, 1929).—A discussion of methods of controlling the concentration of soluble salts in boiler water and the resultant effect on the tendency of the water to "prime" or "foam." E. R. W.

The Influence of the Quality of Water on Industry. E. BARTOW. *Chem. Bull.*, **16,** 191 (June, 1929).—The quality of available water is an important factor in choosing the location for an industry.

The author has confined the discussion to boiler feed water, including the desirable and undesirable properties. Methods for eliminating the undesirable features are given.

A fund of $300,000 is being raised to carry out the study of boiler feed waters. Much of the work will be done in university laboratories. H. T. B.

The Wave Theory of Electrons. G. P. THOMSON. *Chem. & Ind.*, **48,** 311–5 (Mar. 29, 1929).—An interesting, non-mathematical, discussion of atomic and electronic structure. Recent work seems to indicate that the electron is not the simple, negatively charged particle possessing mass by virtue of its charge, that it was formerly supposed to be. "One may picture the free electron as something like a gossamer spider floating through the air at the center of a number of radiating filaments which control its flight as the air wafts them about, or as they are caught by solid objects. . . The wave theory has shown more prospect of accounting for the facts of chemistry than have the orbits, in spite of their long start." E. R. W.

Recent Advances in Our Knowledge of the Structure of the More Common Fats. T. P. HILDITCH. *Chem. & Ind.*, **48,** 212–6 (Mar. 1, 1929).—A review of the work carried out during the past twenty years concerning the separation and identification of the components of natural fats. A bibliography is included. E. R. W.

Some Properties and Theories of Gels. E. HATSCHEK. *Chem. & Ind.*, **48,** 389–99 (Apr. 19, 1929).—*A Messel Memorial Contribution.* A description of the different classes of gels and some of the theories of their structure. A study of optical properties, and of the shape of gas bubbles formed in the gels, presents facts difficult to explain by any theory of gel structure. A list of more than 40 references is given. E. R. W.

Periodic Structure in Gels. E. S. HEDGES. *Chem. & Ind.*, **48,** 233–4 (Mar. 8, 1929).—A discussion of various theories which have been advanced to explain ring formation in gel reactions. E. R. W.

Vitamins in Canned Foods. W. H. EDDY, E. F. KOHMAN, AND N. HALLIDAY. *Ind. Eng. Chem.*, **21**, 347 (April, 1929).—Effect of vitamin value of storage on canned spinach. After three years storage, there was no detectable loss in vitamin A and apparently only a small loss in vitamin C. No distinction was previously made of the two types of vitamin B. However, canned spinach must be regarded as relatively richer in the antipellagric vitamin than in the antineuritic. D. C. L.

Bibliography of Paper Making for 1928. C. J. WEST. *Paper Trade J.*, **88**, 173–231 (Feb. 21, 1929).—This includes the list of journals abstracted, the classification of material, and titles of articles of interest to paper makers. C. E. M.

HISTORICAL AND BIOGRAPHICAL

Edgar Fahs Smith, Chemist. M. T. BOGERT. *Science*, **69**, 557 (May 31, 1929).—A summary of Dr. Smith's life-work in chemistry in the form of a bill owed him by American chemistry. An address delivered at the meeting in memory of Edgar Fahs Smith in Philadelphia, on Dec. 4, 1928. G. H. W.

William Higgins, a Pioneer of the Atomic Theory. J. REILLY AND D. T. MACSWEENTY. *Sci. Proc. Roy. Dublin Soc.*, **19**, 139–57 (1929); *C. A.*, **23**, 2860 (June 20, 1929).—Historical. M. W. G.

Chevreul, 1786–1889. L. PARISOT. *The Ray of Gamma Sigma Epsilon*, **6**, 11–21 (May, 1929).—Every one knows the name and the scientific reputation of the man who called himself the "oldest student" but few persons have been able to frequent him sufficiently to be able to appreciate in Chevreul the man as well as the scientist. This account is written by one who had the privilege and great honor to live in intimacy with the "oldest student" for the last fifteen years of his life.

"Chevreul has reduced to the most rigorous scientific laws the delicate theory of the alliance of colors, notwithstanding the fact that nothing appeared to be less scientific. Upon closely following this question, which the old Master named "*philosophie des phenomenes naturels*," one may see him pursuing without intermission from 1828 to 1864 that law of simultaneous contrast which produces the complete scale of colors. This discovery was not simply a guide to good taste. Chevreul has proved that harmonies of color are submitted to immutable laws that he has revealed and of which the calculation proves the riches. . . .

"Political men, ministers, princes, crowned heads, all forgot the hours while listening to his measured words which expressed powerful and delicate thought on science and philosophy. All left him awed by that superior intelligence which sought above all things, *truth*. . . .

"On the 22nd of April, 1889, he was stricken with a syncope and expired after a few hours, unconscious of his friends and disciples who crowded to his bedside. If the mass of the public did not follow him to his grave, the entire scientific world was there, mourning for the genius that had passed; grateful to him as a benefactor of humanity, and as a man, soaring above all discussions of race, creed, or interest."

G. B. C.

Award of the Nobel Prizes in Chemistry. W. H. EDDY. *Sci. Mo.*, 375–9 (April, 1929).—The Nobel chemical awards of 1927 and 1928 are examples which emphasize the difficulty of separating individual effort and recognition from the efforts and merits of others who have toiled in the same field. To some familiar with the tremendous strides made by American scientists toward the solution of the problem of rickets, its cause and prevention, it came as a surprise when Stockholm announced that the Nobel prize in chemistry for 1928 was awarded to Professor Adolph Windaus, of Göttingen University, for explanation of the nature of the provitamin (ergosterol) which becomes rickets-preventing vitamin D when irradiated with ultra-violet rays. The 1927 award to Professor Heinrich Wieland, of Munich, for his work on bile acids and the origin of cholesterol was recognized as a logical tribute to specific work in a given field. His work may provide the key to the metabolism of ergosterol.

A brief survey of the vitamin studies is given and it is pointed out that Windaus is the key man in the situation, thus justifying his receipt of this international award.

Combined with this article are full-page photographs of Prof. Windaus and Prof. Wieland. G. B. C.

Centenary of Wöhler's Synthesis of Urea (1828–1928). F. G. HOPKINS. *Biochem. J.*, **22**, 1341–8 (1928).—Critical review of the significance of Wöhler's discovery. C. E. M.

The Volta Temple at Como. *Nature*, **123**, 683–4 (May 4, 1929).—There has been recently erected at Como, Italy, a Volta temple. It is a very handsome structure which is designed to be not only a memorial of the great scientist but also to contain whatever

relics are extant. A number of the original instruments constructed and used by Volta were destroyed in a fire in 1889 at the time of the centenary of the discovery of the Voltaic pile. To avoid such a loss a citizen of Como, Francesco Somaini, with his friends, has given money for this fire-proof memorial. It will contain the manuscripts of Volta, any remaining instruments, reproductions of important pieces of apparatus that were lost, together with a bust and bas-reliefs giving important scenes from the life of Volta.

In connection with the temple there is an endowment fund of 500,000 lire, the income of which is to furnish annual prizes of 5000 lire each to distinguished students of Como, or of the canton of Ticino who wish to pursue studies in electrical fields.

F. B. D.

Iron Manufacture and Heat Generation. H. LEWIS. *Nature*, **123**, 762–4 (May 18, 1929).—The author gives a sketch of the manufacture of iron from the probable date 3000 B. C. He shows that the iron production throughout this period was by the direct reduction with charcoal, in furnaces probably not more than four or five feet high; the air being furnished by bellows worked by man power, and the temperature being only high enough to produce masses of malleable iron or, with suitable ores, a steely iron, or a steel.

The production of iron in larger amounts and in molten condition was dependent upon the development of the mechanical blast. Agricola describes such a blast worked with a water wheel and the earliest description of such a bellows would date it about 1435. The later production both in quality and quantity of iron is coincident with the development of facilities for obtaining high temperatures through increasing the amount of air that could be forced into the furnace. In short, it shows a rather interesting relationship between the development of iron and its dependence upon the invention of the air blast. F. B. D.

History of the Development of Fast Dyeing and Dyes. JAMES MORTON. *J. Roy. Soc. Arts*, **77**, 544–74 (1929); see *C. A.*, **23**, 2574 (May 20, 1929); *C. A.*, **23**, 3102 (June 20, 1929). M. W. G.

An Outline of the History of Medicine in India. P. JOHNSTON-SAINT. *Chem. News*, **138**, 333–5, 339–43, 356–9 (May 24–June 7, 1929).—The Sir George Birdwood Memorial Lecture delivered before the Royal Society of Arts, Friday, May 10th.

"Brahma, taking compassion on man's sick, degenerate, and suffering state, produced the Ayur-Veda which contained a treatise of the science of life. . . . The Ayur-Veda itself as we know it from its commentators seems to have been divided into eight parts, two treating of surgery, five of some branch or other of medicine, and one of what was in later ages generally known as the Elixir of Life."

(A note here of special interest to us: "Chemistry" it is true may have been an Arabic word, but the science itself appears in India long before the time of the Arab scholars, for the seventh chapter of the Ayur-Veda treats exhaustively of this science.)

"Susruta was essentially a surgeon and Charaka a physician and it is from these two teachers that the Hindus obtained their science of surgery and medicine in the years to follow after. Susruta was the son of Vishvamitra, a contemporary of Rama. Precisely when he may have lived we do not know; Sir William Jones places the subjugation of India by Rama about the year 2000 B. C. Some philosophic scholars assert Susruta to be a contemporary of the Buddha. To Susruta is due the glory of the discovery of cataract-couching, centuries before it was known to the west, while the plastic surgery of skin grafting and rhinoplasty, only comparatively lately rediscovered in Europe, were frequently practiced by the same great Hindu.

"There was no province of human life, however intimate, for which recommendations were not to be found in the ancient Hindu medical code. What we know today as preventive medicine had its origins in India many centuries back.

"The *materia medica* of the ancient Hindus is a marvel to the modern scientific investigator; and that it was freely borrowed from by both Greeks and Romans cannot be denied.

"Buddhism came and the Brahmin priest fled to the furthest parts of the known world. The Buddhist Dynasties sank, Brahminism was recreated and Buddhist scholars, like those Greeks who with the fall of Constantinople brought the Renaissance to Western Europe, fled with their learning to China, to Tibet, to everywhere.

"If we were to speak the truth we must call Greece not the parent of our modern medicine but its nurse." G. B. C.

Primitive Thinking. The Occult Beginnings of Authentic Science. T. L. DAVIS. *Tech. Rev.*, **31**, 1–4 (July, 1929). M. W. G.

EDUCATIONAL MEASUREMENTS AND DATA

Colleges Test Thousands in State High Schools. *Minnesota Chats*, **2**, 13–6 (June, 1929).—Just before the close of the school year a total of 10,103 seniors in Minnesota high schools completed a special set of tests administered to determine their aptitude for college work. The testing has as its purpose, not to say that a given student shall or shall not enter some college as a freshman next fall, but to obtain information that may be placed before him and his parents, to show with a considerable degree of accuracy the likelihood that he or she will succeed if college work is taken up.

Last year, 560 of the students around the state who took the tests in May, 1928, were classified as probable college failures. Of these 560 there were 313 who entered one of the Minnesota colleges or the University, despite the facts placed before their parents, and of these 313 a total of 296 have already fallen below satisfactory standing, leaving only a margin of 17 for whom the prediction did not hold good. C. E. M.

Capacity Tests. Y. B. SMITH. *Bull. Am. Assoc. Univ. Profs.*, **15**, 393–4 (May, 1929).—After four years' trial the Columbia University Law faculty has made capacity tests dealing with abstractions and symbols a part of their entrance requirement.

During the four-year experimental use of the tests over 90 per cent of the men who rated below 75 on the test failed to do good work in the law school. Three-fourths of these men were ultimately excluded from the school because of low scholarship. On the other hand, however, a good score in the test did not indicate as great a certainty of success in the school as the low rating pointed to failure. B. C. H.

A Brief Method of Evaluating Test Material. B. R. BUCKINGHAM. *J. Educ. Res.*, **19**, 159–68 (Mar., 1929).—The author discusses the difficulties in constructing standard tests. He gives an account of an investigation in which test data were used in finding the difficulty of additional data, illustrating a short method of evaluating material—with a criticism of the accuracy of the result. R. M. P.

A Practical Technic for Determining the Relative Effectiveness of Different Methods of Teaching. E. O. MELBY AND A. LIEN. *J. Educ. Res.*, **19**, 255–64 (April, 1929).—The purpose of this work was to compare the effectiveness of the drill and the project methods on one criterion—that of facts learned.

Groups of pupils as they existed in the school organization were utilized. A technic is described which permits a number and variety of experiments to be conducted *under existing school conditions*. Evidence of the practicability of this technic, rather than proof of the relative value of the teaching methods investigated, is believed by the authors to be the greater contribution of the article. R. M. P.

What a Freshman Wants to Know. L. RAINES. *Sch. Soc.*, **29**, 577–8 (May 4, 1929).—The results of a questionnaire, compiled for the purpose of determining the necessary information and facts to be given the entering freshman student, are stated in this article. The questionnaire was given to 125 college students—two-thirds being second quarter freshmen and the remainder second- and third-year students.

K. S. H.

"Honor" Engineering Students: Their Characteristics and Reasons for Success. M. E. HERRIOTT. *J. Eng. Educ.*, **19**, 871–83 (May, 1929).—A study of the student personnel of the College of Engineering of the University of Illinois resulted in the following findings: "these *honor* engineers, with the exception of three sophomores, maintained a scholastic average of better than *B* up to the time data were collected. In chronological age, they did not differ markedly from college students in general nor from those who later distinguished themselves, except that there was a noticeable absence of the very young and a tendency toward over-ageness. In intelligence, all of them (except one student with a language handicap) made scores better than the median college student, and more than 50 per cent of them equaled or exceeded the upper 10 per cent of college students in general. Their study habits were in fairly close agreement with those advocated by authorities. They spend an average of an hour and a half in preparation per class meeting for classes demanding such study. In personality, they appeared to be superior to the average college student. About half of them engaged in remunerative employment or homework to the extent of a hundred hours or more during the school year. They appeared to be rather prolific readers. None of them had ever been involved in disciplinary difficulties while in the university. The most outstanding reasons assigned by them for their success may be classified either as good study habits or proper attitudes toward school work."

The most interesting part to us of this report is that portion devoted to the *study habits* of these *honor* students. The practices regularly followed by the majority were:

1. Systematically review the textbook before final examinations.

2. Explain problems and processes for other students when there is an opportunity to do so.
3. Systematically review the textbook before quizzes.
4. Ask either in class or in conference about items needing explanation.
5. Write up chemistry experiments in the laboratory with the experiment still set up.
6. Memorize rules and formulas only after thoroughly understanding them.
7. If you do not understand how to proceed in solving a problem after reading it, try to reason out the procedure or look up the solution to similar problems, preferably the former.
8. When doing an experiment, read through, and try to understand all of the directions before beginning work; do not merely read the directions as the experiment progresses.
9. Read over an assignment rapidly to get a general idea of the author's treatment and then study in detail.
10. Recite your lesson occasionally to yourself, either aloud or in a whisper.
11. Do not confuse that which is not assigned with that which is.
12. Systematically review your textbook when you need facts previously learned if you do not recall them.
13. Understand exactly what is given and what is to be done before you begin to solve a problem.
14. Read your textbook relative to the subject of a laboratory experiment before doing the experiment.
15. Try to determine the reasons for statements made by an author.
16. Try to connect important points with something in your own experience.
17. Apply rules and formulas soon after learning them rather than trust that you will remember them without doing this.
18. In case the answer to a problem is not given by the instructor or textbook, solve it before trying to ascertain the correct answer from your classmates or those who have previously taken the course.
19. If a problem is made up of a series of steps, be careful to separate it into the several steps.
20. Frequently supplement what a lecturer says by supplying examples of your own, thinking of what some one else has said along the same lines and the like.
21. Be sure that you clearly understand what your instructor asks you to do in his assignments.
22. Divide your study of an assignment into two periods.
23. Do each assignment with dispatch, but complete all work.
24. When possible, check your answers to problems.
25. Check each operation as performed, rather than leave all checking until the entire problem is completed.
26. Be sure to find out the meaning of unfamiliar terms.

It is also of interest to note the study practices that are often advocated by authorities but which few of these students ever followed.

1. Follow a fairly definite study schedule.
2. As you read, keep notes in some systematic way, such as in a notebook.
3. After studying an assignment, write out a summary or outline of the material read.
4. Systematically review your textbook daily. C. E. M.

The Correlation of Laboratory and Classroom Work in the Teaching of High-School Chemistry. G. BAGBY. *J. Educ. Res.*, **19**, 336–40 (May, 1929).—The author states that the purpose of this study is to compare the relative efficiency of three methods of correlating classroom and laboratory work as measured by immediate and delayed recall of subject matter. By method 0, there was no class work before the laboratory; by method 1, a preview was given in the class the day before the laboratory; by method 2, the topic was completed in the classroom before the experiment was begun.

Three groups of thirty pupils each were chosen for this study. The classes were rotated at the end of each thirteen weeks. Objective tests were given, the results being used as bases of conclusions in regard to the relative efficiency of the three methods.

The following conclusions were given: (1) A change in the relative time of classwork and experiment has little effect upon pupil achievement. (2) Telling the results of an experiment before working it out in the laboratory does not appreciably affect what the pupil learns as measured by two standardized tests. (3) For purposes both of immediate and delayed recall, pupils having medium or low intelligence may profit

slightly more by utilizing the first day for class discussion, the second for experiment, and the third for classwork. (4) Pupils of high intelligence do better work both in immediate and delayed recall either by completing the subject matter in the classroom before going into the laboratory or by doing the experiment before having any classwork whatever. R. M. P.

A Quantitative Investigation of Instruction in High-School Physics. P. S. MILLER. *J. Educ. Res.*, **19**, 119–27 (Feb., 1929).—This study was conducted with the purpose of determining the efficiency of instruction in physics in twenty-eight high schools.

The author describes the method by which questions for tests were selected. A list of the questions is included and the key to answers given.

In the summary the author states the following: (1) Results indicate that pupils have not acquired facts. (2) Size of class has no consistent effect on the score attained. (3) Pupils in the college preparatory curriculum attain higher scores than those in the normal preparatory, in the general, and in the mechanical curricula. (4) Students who study physics in the fourth year of high school attain the highest scores. (5) The teachers' marks and the scores attained in the test do not bear a close relationship. R. M. P.

THE METHODS AND PHILOSOPHY OF EDUCATION

Graduate Study and Research in Education. C. V. GOOD. *High-School Teacher*, **5**, 148–51 (May, 1929).—The author lists "important problems in graduate study and research" as:

(1) A working definition of research and a recognition of the characteristics of scientific investigations.
(2) A knowledge of the steps involved in scientific thinking.
(3) Knowing the sources of information in educational literature and evaluating such sources when found.
(4) A knowledge of the technical vocabulary and terminology involved in educational literature.
(5) Ability to state and define an educational problem and a recognition of those yet unsolved.
(6) Learning to choose from technic of investigation available for the collection of data.
(7) Acquiring ability to analyze and organize data into tabular or graphic form.
(8) Developing skill in the interpretation of data and the formulation of conclusions.
(9) The art of reporting research and preparing it for publication.
(10) Training research workers and the guidance of graduate students.

Many of these problems are discussed in the article. B. C. H.

Objectives and Activities in the Extra-Curricular Field Which Illustrate the Seven Cardinal Principles of Education. M. B. DEE. *Education*, **49**, 583–91 (June, 1929).—For curricular activities, that set of objectives which has been widely accepted is probably the "Seven Cardinal Principles of Education," first formulated in the report of the commission on the Reorganization of Secondary Education of the National Education Association. If we are to evaluate extra-curricular in comparison with curricular activities, may we not attempt to do so by seeing how far both may lead toward the same objectives?

A carefully worked-out list accompanies this discussion under the seven headings: health, command of fundamental processes, worthy home membership, vocation, citizenship, worthy use of leisure, ethical character. The list is suggestive merely of how a well-organized extra-curricular program might contribute to the principles most commonly recognized as the fundamental objectives of curricular work.

A bibliography on extra-curricular activities is included. G. B. C.

Who Is Practical in Education? C. D. CHAMPLIN. *Sch. & Soc.*, **29**, 700–2 (June 1, 1929).—Those persons are practical who give the best they have—using common sense and making repeated applications to life. K. S. H.

The Curse of College. G. H. ESTABROOKS. *Education*, **49**, 416–23 (Mar., 1929).—This is quite an entertaining article; better than that, it contains an excellent point.

We are more or less what Napoleon called the English, a nation of shopkeepers. Not only are we shopkeepers but we strive to be *efficient* shopkeepers. Even Napoleon who was in the habit of saying things about the English never accused them of this. We carry this attitude over to our colleges and demand to see cash return for our money.

The author offers a declaration of faith as an antidote to the prevalent gloom. "Our liberal arts colleges are among the best institutions we have in modern society.

The ideals which they uphold in the physical, mental, and moral fields are of the very finest. And having indicated my insanity by that statement I will furnish absolute proof of my demented condition by further stating that they give excellent preparation for future life in the community."

"We do not attempt to compete in these fields. That would be rank folly. We merely give the preparation, the cultural background, the social poise." G. B. C.

The Preliminary Course on "How to Study" for Freshmen Entering College. E. S. JONES. *Sch. & Soc.*, **29**, 702–5 (June 1, 1929).—Dr. Jones describes this course as it has been given at the Univ. of Buffalo for the past 3 years. A comparison of the results at the end of the course is given and he also tells of what value it has been. K. S. H.

Paying the Student to Study. EDITORIAL. *Rev. Revs.*, **79**, 94 (April, 1929).—Stevens Institute of Technology will inaugurate next year a sliding scale of tuitions which in effect will mean the exemption of certain students from payment of parts of their tuitions. The amount of exemption will be determined by the student's rating in scholarship and extra-curricular activities. G. H. W.

College Finances. H. N. DAVIS. *Bull. Am. Assoc. Univ. Profs.*, **15**, 365–71 (May, 1929).—"Why is it that so few of us in the field of higher education have the courage to demand either that our benefactors get what they pay for or that our students pay for what they get?"

"Our job in colleges is to produce and then to 'sell' ideas and ideals, to do things that are *worth* backing, to *deserve* loyalty and support—any college that really succeeds in these . . . functions will . . . receive a most astonishing succession of unsolicited gifts." The benefactor gets what he pays for only when he makes his gift unsolicited.

Deficits should be met by students more nearly paying for what they get. Americans wish to pay for what they get and American students are American.

Another satisfaction which a benefactor should derive from his benefaction could be measureably augmented by seeing to it that the other man's son, whom the benefactor helps to educate, shall be increasingly of the type described by "marked ability and superior character." To realize this, more of such funds, from benefactors, should go to provide tuition for the superior college student and less to the less promising one. In other words, have the tuition rates gaged by a sliding scale favorable to the best type of student and less lenient to the near-delinquent one.

Such practice would raise the question, "which are our most promising students?" Three bases for an answer to this question are suggested: aptitude tests, college grades and honor points attained through extra-curricular activities. A proper weighting of these three relative to each other, and especially the different types of the third, constitutes one of the problems in the selection of the promising student. B. C. H.

Leadership. N. E. GORDON. *The Ray of Gamma Sigma Epsilon*, **6**, 5–10 (May, 1929).—"The world is calling for leaders; the demand is greater than the supply. Especially is this true in science where frontiers must continually be broken if real progress is to be made."

Ten characteristics which should be carefully considered in prospective leaders are: health, creative ability, book ability, ability to coöperate, intellectual honesty, persistency, faculty of observation, enthusiasm, character, scholarship.

Some of the high points in the discussion which follows are:

"A leader must possess an ingrained humility of mind, a spirit of coöperation before it is caught by men. Coöperation is contagious. When this virus spreads through the ranks there will be the feeling among the men, 'you first, I follow' . . .

"Many of our greatest advances in science have arisen out of the investigation of small discrepancies which less honest workers might have passed over. . . .

"Careful observation has a prominent place in leadership. The blind cannot lead the blind, and expect to arrive anywhere but in the ditch."

There follows a rating chart by which a student's leadership ability may be graded. G. B. C.

Some Symptoms of Intelligence. H. T. EATON. *Education*, **49**, 437–9 (Mar., 1929).—Although certain symptoms of intelligence are valuable to the educator, they do not necessarily tell the whole story. The wise teacher will always be clever enough to modify her judgment where it is necessary and advisable to do so.

1. In the first place, the age of the pupil in any given class is of importance. It is always worthwhile to keep the record of each pupil's age in the class record book, and to note especially the pupils of the class who are either very much under or very much over age.

2. The past scholarship of the pupil is relatively important, but is no absolute

criterion from which to judge his present and future performance. About 50% of the time previous failure demonstrates that the pupil is not exceptionally bright. On the other hand, one must not forget that the other 50% of the time the student has failed because of lack of application.

3. Another sign of intelligence can be noted in the result of any simple vocabulary test.

4. The ability to read correctly, clearly, and with expression is in itself a sign of reasonable intelligence, since reading shows an adequate vocabulary. G. B. C.

Some Principles on the Use of Visual Methods in Higher Education. F. N. FREEMAN. *Educ. Screen*, **8**, 100–1, 135–6 (April, May, 1929).—The principles presented are:

1. Visual education has a limited and specific purpose. "Some aspects of subjects might better be taught by some other method." Concrete experience is partly visual and partly gained through other senses.

2. The concrete is relative. What is concrete for one person is abstract for another or what is concrete at one time in a person's experience may be abstract at another time. Visual aids may at one period of an individual's learning be very acceptable and at a later time be only boresome.

3. In higher education less attention needs to be paid to interest. More dependence can be put upon the inherent intellectual interest incited by the subject itself.

In applying the above principles some suggestions of a general nature are offered:

1. A first need is to determine what are the essential concrete experiences required for an understanding of the subject to be taught.

2. An inquiry, next in order, is; which of these necessary experiences must be supplied?

3. Finally, what are the best methods of filling these gaps in the students' necessary experience? It is in answer to this last that visual aids may be used. Here, however, decision has to be made between the "movie" slide, demonstration and other forms of such teaching help.

In making this decision economy of cost and time, convenience, modifiability, and flexibility of organization are prime considerations. B. C. H.

Study Habits. See Abstract, "Honor Engineering Students: Their Characteristics and Reasons for Success," THIS JOURNAL, **6**, 1585 (Sept., 1929). C. E. M.

Henry David Thoreau—A Pioneer in the Field of Education. H. E. HURD. *Education*, **49**, 372–6 (Feb., 1929).—We are hearing much about "the project method" in modern pedagogy. This man who built his own shack at Walden and hoed his own garden, went up and down his world pleading for vocational training. The extra-curriculum activities of a student educate him!

Whatever may be the limitations of Henry David Thoreau's thinking, he faced the light of learning, concluding his philosophy of knowledge with these prophetic words: "The highest that we can attain to is not Knowledge, but Sympathy with Intelligence." G. B. C.

THE TEACHING PROFESSION

Great Teachers and Some Methods of Producing Them. R. L. KELLEY AND R. E. ANDERSON. *J. Educ. Res.*, **20**, 22–30 (June, 1929).—See Digest—College Teaching—THIS JOURNAL, **6**, 1341 (July-Aug., 1929). R. M. P.

Ideas and Ideals of Teachers. I. D. WEEKS. *Education*, **49**, 424–9 (Mar., 1929).—During the past few months a study was conducted to ascertain what teachers and preparatory teachers were thinking relative to important and significant ideals and institutions. The author is well aware that the study is not wholly scientific. However, the conclusions are more than sheer personal opinion.

The summary and conclusions tend to show that teachers resemble the folk in "Main Street" in their ideas and ideals of amusement, recreation, religion, education, home, and literature. While these ideals are probably moral and many times wholesome, they are not analytical or profound in thought.

It may be true that the lack of maturity of many of the persons answering this questionnaire would explain in part the commonplace thinking, inasmuch as the ideas of young teachers may not be definitely and permanently formed. However, many of the teachers going into the public schools are young and inexperienced and will exercise either a positive or negative influence over boys and girls. In lieu of this the citizenry of the morrow is not destined to rise far in advance of the citizenry of today.

The questionnaire appears to us to be of little value. The final conclusions brought to bear on answers to such questions as: "Do you believe in prayer? Would you

like to be a minister or a minister's wife? Do you dance and why? Do you pet? Do you feel that an education will relieve you of hard work?" would necessarily be too arbitrary to be considered very seriously. G. B. C.

The Point of View in Teaching. E. R. SCOTT. *Education*, **49**, 499–505 (April, 1929).—We can allow at the outset that teaching is a series of complex reactions since the situation to be met is one which has many variables. It follows that habitual reactions will not suffice, although it is possible for a teacher to reduce his actions in the classroom very largely to a set of habits.

On the highest plane of teaching effectiveness the instructor adds to immediate subject matter objectives ends which are more comprehensive. That is, he has a philosophy of education which makes a difference in his teaching. This he has distilled from an exhaustive study of life in all its various aspects.

The desired point of view in teaching can be expressed in the query, What should I do as a teacher to bring about in my pupils an intelligent grasp of life? Method is important, but the possession of this point of view is an antecedent condition to good method, a fact which is all too often completely ignored in our teacher-training institutions. G. B. C.

Professors' Salaries. ANON. *Chem. Bull.*, **16**, 194 (June, 1929).—Three courses are open to the man with a bachelor's degree:

(1) He may go into high-school teaching, in which advancement is slow and which offers little opportunity for research.

(2) He may go into industry. Progress depends on individual ability and circumstances encountered. In general, men with the B.S. degree gravitate to occupations not directly connected with chemistry.

(3) He may take graduate work. When he has secured his doctorate, the financial question is of great importance. The difference in salary offered in university teaching and in industry makes the latter the most attractive. Thus, many brilliant minds are forced into industry where research is limited to problems of immediate interest.

University positions are quite secure, and because of this fact, men of mediocre ability find the life attractive, often preventing the rise of younger and more brilliant men who do not have sufficient seniority. The status of men who have had their degrees for some time is such that the mediocre man receives more in teaching than he ever would have received in industry, but the man of ability receives less than he would in industry for a position of equal responsibility.

These suggestions may be offered to improve the situation.

(1) That salaries in the lower academic ranks be raised to the point that young men may start university life without too much financial embarrassment.

(2) That instructors be chosen carefully.

(3) That rapidity of promotion depend on ability.

(4) That there be no security of academic tenure until a man has proved himself to be outstanding either as a teacher or as a research worker.

(5) That promotions to full professorships be made on the recommendation of a committee of eminent men in a particular field outside of the institution in which promotion is to occur.

(6) That the large universities of the country make their salary scales uniform and adopt similar standards of promotion. H. T. B.

The Teacher's Salary. W. W. LUDEMAN. *Education*, **49**, 592–4 (June, 1929).—The teacher is concerned with the salary scale, for it determines her efficiency to a large extent. If she thinks she is well paid for her efforts, she will make larger efforts. Granting that our school boards have been lax in setting up standards of determining teachers' salaries, how can the problem be solved and salaries be adjusted so that they are fair to all parties concerned? The wages of the teacher should be calculated on the basis of her investment, just as income, rent, and profit are figured on investment in the business world.

The time is at hand when salaries for teachers are going to be more carefully calculated upon more business-like grounds rather than upon bases which have been unfair to the members of the profession. It is safe to predict that when this has been brought about the general teaching efficiency will be much higher than at the present time. G. B. C.

The Single Salary Schedule. W. SOOY. *Education*, **59**, 294–308 (Jan., 1929).—Mr. Bicknell, with his great degree of foresight, would give to the teachers a scale of salaries which shall recognize grade of qualification and experience, making the ultimate salary one to which the best talent will be ambitious to aspire.

Single salary schedules are apparently doing more than any other administrative

device to increase efficiency in public education, to augment the training of teachers, and to elevate professional standards.

Differences in salary cannot be justified on the basis of grade or subject.

Mr. Guy Whaley, Chairman of the California Teachers' Association, has proposed a new standard for the single-salaried schedule. It begins with a base represented by 100% for holders of standard bachelor's degrees, with 10% extra for A.M. degree granted on one year of residence study, 20% extra for A.M. degree granted on two years of resident study, and 30% additional for the Ph.D. degree or equivalent. Normal school students of a two-year course get 80% of the base, while normal school graduates of a three-year course receive 90% of the base.

The ideas for which the single-salary schedule stands are bound to permeate public school practice throughout America. There are bound to be delays, modifications, and readjustments, but the basic principles are sound and inevitably must prevail.

Preparation, experience, and professional growth present the "only reasonable basis" for salary differences; "justice" and "fairness" to the teachers were named by thirty-six superintendents as the basic argument for the single-salary schedule.

G. B. C.

What Is a Professor Worth? E. A. BURNETT. *Bull. Am. Assoc. Univ. Profs.*, **15,** 396–7 (May, 1929).—Some elements considered in answering this question are enumerated:

The professor is more fundamental to an institution than "massive buildings."

The professor should be more than a teacher. He should be a born leader.

Every professor should spend approximately 20% of his salary upon self-improvement.

Every professor must save for his old age. His preparation for his life work makes such saving impossible "until he is well along in his thirties."

The most outstanding professors should be able to enjoy the same comforts of life enjoyed by the outstanding men in other professions.

B. C. H.

What a Teacher Should Expect from the School. F. P. GRAVES. *Sch. & Soc.*, **29,** 557–60 (May 4, 1929).—Dr. Graves discusses some of the outstanding problems in the training of teachers. Training schools are but the beginning of one's education as a teacher. The necessary skill required in the utilization of the theory and methods obtained in training schools can be acquired and developed only through their application.

Special instruction might well be given some of the new graduates and particularly is one at a disadvantage if placed in a community—the character of which is unfamiliar to him. But even more important is the necessity of placing a teacher where he will be stimulated or providing him with the proper stimulus that will make for professional advancement.

K. S. H.

The Need for Unity in Teacher-Training Courses. R. H. ECKELBERRY. *Education*, **49,** 321–30 (Feb., 1929).—There has been as yet only a partial abandonment of the Aristotelian idea that "a truly cultural or liberal education cannot have anything in common, directly at least, with industrial affairs," and that in the degree in which a subject is vocational it ceases to be cultural. If we are "democratic" and "liberal" in our attitude, we assert that every one should receive a "cultural education" and a "vocational education," but many of us do not see that every one should receive an education which is at once cultural and vocational.

In teacher-training courses, as in the work of the public schools, we are still inclined to think of liberal and vocational courses as opposed in character. Every student must take both types of courses, but the two types, instead of being taught in intimate relation to each other, are taught in more or less separate compartments, to the serious detriment of both.

The training of teachers, as it is often conducted, with the liberal and professional subjects taught in water-tight compartments, suffers from the same evils that attend the separation of liberal and vocational subjects in the work of the public schools; each set of subjects loses in effectiveness as a result of the artificial separation.

It is probably not too much to hope for a time when in every college that trains teachers there will be for each subject ordinarily taught in the schools at least one teacher who knows the subject thoroughly, who is a skilful teacher, and who has sympathetic understanding of school problems.

G. B. C.

A General Policy Concerning Demonstration Teaching in City Schools Used for Teacher-Training Purposes. E. SELKE. *Education*, **49,** 489–98 (April, 1929).—While adequate facilities for observational purposes, demonstration lessons, and student teaching must be maintained for the practical training of prospective teachers, yet

just how much demonstration teaching is necessary, and by whom it should be given, are problems which deserve serious consideration. No matter what contract may exist, no matter how agreeable the relationship between the city school and the teachers' college, the system is vastly more difficult to administer than the campus training school.

The general policy concerning demonstration teaching in city schools used for teacher-training purposes, formulated by the author from the summary of replies to a questionnaire collected, is as follows:

1. Arrangements for the teaching of demonstration lessons are made through the director of training who also decides upon the general method to be used.
2. The demonstration lesson is taught by the regular classroom teacher.
3. Regular college instructors other than teachers of method or special subjects do not teach classes of children in the training school. G. B. C.

How Teachers May Help Students Secure Positions. L. W. MCKELVEY. *Education*, **49**, 522–8 (May, 1929).—Under this intriguing title, Dr. McKelvey gives us a few pointers on the ideal business letter for an applicant. We call it an attempt to deceive the poor business man. G. B. C.

MISCELLANEOUS

Coöperation in Science and Industry. J. F. THORPE. *Chem. & Ind.*, **48**, 281–8 (Mar. 22, 1929).—The Presidential Address delivered at the Annual General Meeting of the Chemical Society. A higher standard of living necessitates an increase in national productive capacity. "The age is at hand, if it is not already here, in which the changing majorities of governments will no longer be able to determine major policies as of war, financial, and fiscal, except in directions approved by organized industry." Four types of coöperation, (1) internal, (2) with pure science, (3) with government, (4) with laborer, are necessary if this responsible position is to be reached. Methods by which each of these has been brought about, and some of the results, are outlined in detail. E. R. W.

Chemistry and Electricity. H. E. HOWE. *Gen. Elec. Rev.*, **32**, 180–6 (April, 1929).—"I doubt if any combination of sciences has accomplished more for society than chemistry and electricity working together." In enumerating these coöperative accomplishments the author includes electrolysis of salt yielding caustic soda. Caustic soda makes possible rayon, artificial sausage casings, and cellophane. The production of pure aluminum; calcium carbide; electroplating of chromium; electro-deposited rubber; the alloy, permalloy; synthetic resinoids of the Bakelite type; improved transformer oils, dry and storage batteries; and glass of pyrex quality also represent activities mutually advantageous to both sciences.

A rather challenging comment on research in industry is; "It is far better to know the fixed attitude of a corporation toward research than to know its fixed assets, if one is deciding where to place his investments." B. C. H.

International Chemistry. A. M. PATTERSON. *Science*, **69**, 531 (May 24, 1929).—"Scientists have always been internationally minded." Two international organizations of chemists were in existence up to the time of the great war, The International Congress of Applied Chemistry dating from 1889, and an International Association of Chemical Societies dating from 1911.

In 1918 the International Research Council was organized by delegates from the scientific academies of the allied nations and an International Union of Pure and Applied Chemistry took the place of the old Association of 1911. It has held nine annual meetings. Numerous special commissions are parts of this organization.

The Union is a small select body, and as such may lose the support and interest of chemists in general. It has contemplated calling a true international convention and one seems assured for 1932 in Madrid. French is the official language of the Union.

The author discusses the work of the Union and the possible functions of other international organizations. G. H. W.

American and Canadian Chemists Meet at Toronto. *Can. Chem. & Met.*, **13**, 167–72 (June, 1929).—A full report of the meeting of the American Electrochemical Society and Canadian Chemical Organizations at Toronto during the week of May 27th. D. C. L.

Every great and commanding movement in the annals of the world is the triumph of enthusiasm. Nothing great was ever achieved without it.—EMERSON

Local Activities

Through these columns, the JOURNAL desires to render a two-fold service.

1. Keeping its readers in touch with the varied interests of institutions, A. C. S. sections, teachers' asssociations, and other organizations throughout the country. Items of general interest would include: (1) notices of local scholarships or fellowships; (2) notices of any special gifts to chemical organizations or departments—as fellowships, endowments, laboratory gifts, library gifts, etc.; (3) accounts of meetings, social functions, exhibitions, chemical entertainments, etc., which might be suggestive to other organizations (where original or unusual features are included it is desirable that they be described in some detail); (4) news notes concerning persons of sufficient prominence in their respective fields to make their movements of general interest; (5) promotions within, or changes of, personnel of a department; (6) announcements of new or unusual courses in chemical education or special fields of chemistry; (7) notes on new chemistry buildings or laboratories, stressing the unique features.

2. Providing an exchange column for positions. That is: (1) any teacher who is a subscriber to the JOURNAL, desiring to change his position, may advertise once a year without charge (correspondence will be handled through the editorial office, if desired); (2) any notices of vacancies, in which chemistry teachers and chemists will be interested, will also be published.

The responsibility of reporting items for this section rests entirely with the local institutions and organizations. It would be desirable to have some person connected with each organization and institution appointed to report regularly.

Suitable material sent to the editorial office before the 20th of each month will be published in the following month's JOURNAL. The Editorial Staff must necessarily reserve the right to abridge or totally reject any items submitted. If the above suggestions are followed, however, the necessity for such action will be largely obviated.

PRINCETON UNIVERSITY

Formal Opening of the Chemical Laboratory

SEPTEMBER 26, 27, AND 28, 1929

THURSDAY, SEPTEMBER 26

(Daylight Saving Time)

The exercises formally opening the Chemical Laboratory will take place on the terrace of the Laboratory at 12.30 o'clock.

Delegates to the Exercises are requested to register at Nassau Hall not later than 11.30 A.M. They may robe in the Faculty Room.

At 12.15 o'clock, the Academic Procession, consisting of the Trustees and Faculty of the University, and delegates from universities, colleges, scientific institutions and learned societies, will form at Nassau Hall and proceed to the Chemical Laboratory. Academic costume will be necessary.

After the Exercises, luncheon will be served at the Princeton Inn to delegates, invited guests, and the members of the Department of Chemistry. Tickets may be obtained at the Exercises.

The Laboratory will be open for inspection during the afternoon.

At 4.00 P.M. tea will be served in the Library of the Laboratory by the ladies of the Department of Chemistry.

At 8.30 P.M. a Public Lecture will be delivered in the Auditorium of the Laboratory by Professor F. G. Donnan, F. R. S., University of London.

10.00 A.M. Conference on Catalysis and the Mechanism of Chemical Reactions. Conducted by DR. IRVING LANGMUIR of the General Electric Company, Schenectady, N. Y. The Auditorium.

2.30 P.M. Conference on Catalysis and the Mechanism of Chemical Reactions. Conducted by PROFESSOR DR. MAX BODENSTEIN, Physikalisch-Chemisches Institut, Berlin. The Auditorium.

8.30 P.M. Public Lecture by PROFESSOR LAUDER JONES, Princeton University. The Auditorium.

SATURDAY, SEPTEMBER 28

10.00 A.M. Conference on Catalysis and the Mechanism of Chemical Reactions. General Discussion. The Auditorium.

Columbia University. During the latter half of June, Dr. Henry C. Sherman, Mitchell Professor of Chemistry, Columbia University, lectured on the chemistry of nutrition in the summer session of the Colorado Agricultural College; and on June 24th he addressed a joint meeting of the college assembly, the local Sigma Xi Club, and visitors from several chapters of the society upon "Science in the Service of Health and Longevity."

Claude S. Hudson, recipient of the Willard Gibbs Medal for 1929, received the official presentation on May 24th at a reception held by the Chicago Section of the American Chemical Society at the Palmer House. Dr. Hudson was chosen for the award because of his distinguished work on carbohydrate sugars carried on in his past twenty years with the government, where he is now chief of chemistry of the U. S. Public Health Service. The presentation was made by Dr. William Lloyd Evans, who only three months before had received the Nichols Medal from Dr. Hudson.

F. C. Frary, director of research of the Aluminum Company of America, was elected president of the American Electrochemical Society at its annual meeting in Toronto on May 29th. Dr. Frary has filled his present post with the Aluminum Company since 1919, when he came there fresh from work in the Chemical Warfare Service. At that time his outstanding achievements were the invention, with Dr. S. Temple, of "Frary" metal, and the development, with Major D. J. Demorest, of the largest phosgene plant in the world. Dr. Frary began his career, after graduation from the University of Minnesota in 1905, with ten years' teaching experience at the same school.

Charles E. Munroe, chief explosives chemist of the U. S. Bureau of Mines, was guest of honor at a luncheon given in Washington on May 23rd by his associates and close friends in recognition of his eightieth birthday. A bronze medal, bearing his portrait, was presented to Dr. Munroe, a feature of the gift being that its delineation had been produced by the "Munroe effect" of detonation by an explosive. O. P. Hood, acting director of the Bureau of Mines, presided at a gathering well designed to give intimate recognition to a long career of achievement in the field of explosives and invention.

A. H. Bucherer, Obituary. The issue of the *Physikalische Zeitschrift* for January 1st contains a photograph and an obituary notice of Prof. A. H. Bucherer of Bonn, who died in May, 1927, written by his former colleague, Dr. R. Thomaschek. He was born in Cologne on July 9, 1863, the eldest of six children of H. Bucherer, a chemical manufacturer, and his wife, a musical and highly educated English lady. He was educated at the Cologne High School, where he displayed a gift for languages. After serving his year in the army and spending a year at the Hanover Technical School, he went in 1885 to the Johns Hopkins University, Baltimore, where he studied under Prof. Ira Remsen, and for a time held a lectureship, then in 1893 to Cornell University, and in 1895 returned to Germany to complete his studies under Prof. Braun at Strasbourg, and took his doctor's degree 1896. After a further three years at Leipzig under Ostwald, and at other universities, he became a lecturer on physical chemistry at Bonn in 1899. Later he became honorary professor, a post he resigned in 1923. From his youth he showed himself of independent thought, little disposed to conciliate those from whom he differed, and this attitude did not smooth his way in life. He is best known for his "deformable electron" and for his experimental determination of the influence of the speed of an electron on its apparent mass. He was not satisfied with Einstein's relativity theories, and was engaged toward the end of his life in an endeavor to deduce all the results of that

theory and remove some of the difficulties it has raised, by a logical development of classical mechanics.—*Nature* (London), **123,** 463 (Mch. 23, 1929).

Death of Professor Moureu. We regret to announce the death of Dr. C. L. F. Moureu, the eminent French chemist. Born in 1863, he had been for the last 12 years professor of organic chemistry in the College de France, and was a past president of the International Union of Pure and Applied Chemistry. Among his published works were *Notions Fondamentales de Chimie Organique* and *La Chimie et la Guerre,* as well as numerous original papers on organic and other branches of chemistry. He rendered important service during the war.—*Chem. Age,* **20,** 586 (June 22, 1929).

Professor P. Walden, of Rostock, has received the Leblanc medal of the Société Chimique de France.

Liebig Portrait Presented by British to German Chemists. Some two years ago Mrs. Alec Tweedie presented to the Chemical Society a portrait of Liebig which is said to be the only one in existence. When the Society sent it to Germany last year for the Liebig-Wöhler centenary celebration, it aroused so much admiration that some of the prominent members of the British society decided to subscribe toward the cost of an exact copy. The commission has now been executed, and, according to present arrangement, three officers of the British body—Professor J. F. Thorpe (president), Professor F. G. Donnan (foreign secretary), and Professor C. S. Gibson (joint hon. secretary)—will go to Berlin shortly to present the copy to the German Chemical Society.—*Chem. Age,* **20,** 356 (April 13, 1929).

The Danish Chemical Society this year celebrates the fiftieth year of its existence.

The German Chemical Society held its annual meeting recently in Berlin. The president, Professor H. Wieland, of Munich, said that the number of members was 5265, and that the financial year 1928 a deficit had, by the assistance of the industry, been avoided. The centenary of the *Chemische Zentralblatt* was to be celebrated on November 11th. Professor Wieland remains president until May 31, 1930; the vice presidents are Professors H. Freundlich, C. Neuberg, A. Windaus, and P. Walden; the secretaries, H. Leuchs and F. Mylius; the treasurer, A. von Weinberg; and the librarian, A. Rosenheim.—*Chem. Age,* **20,** 591 (June 22, 1929).

Nova Scotia Institute of Science. Founded some 67 years ago, the above Institute is apparently in a healthy condition judged by the number of excellent papers submitted during each session. During the 1926–27 session a successful science exhibition was held in coöperation with the Science Department of the Dalhousie University, which was attended by about 5000 persons. During the same session the government grant was restored after a lapse of 20 years. From the Report we learn that the committee in charge received enthusiastic support and coöperation from the science teaching staffs and students of Dalhousie University, the faculty and students of the Maritime College of Pharmacy, the electrical department of the Nova Scotia Technical College, the Atlantic Experiment Fisheries Station, and radio station CHNS.—*Chem. News,* **138,** 103 (Feb. 15, 1929).

Plant Scientists to Meet for Summer Conference. According to *Science Service,* the annual summer conference of plant pathologists will meet in Raleigh, N. C., on July 29th for a three days' conference on the diseases peculiar to crops grown in the South.

The American Phytopathological Society, meeting for the first time with its Southern division, will proceed from Raleigh to Duke University at Durham

and the University of North Carolina at Chapel Hill, and thence through the agricultural section, finally terminating the three-days' trip at Hamlet.

The Society meets every summer in conference to study some particular phase of plant diseases attracting the attention of a large number of its workers. The present meeting this year will deal more generally than usual with the various diseases more or less restricted in their distribution to the Southern states and to North Carolina in particular.

Chemists' Club Activities. According to the *News Edition* of *Industrial and Engineering Chemistry*, the newly elected officers of the Chemists' Club are: president, L. V. Redman; vice president, H. B. Bishop; non-resident vice president, Edward R. Weidlein; secretary, Robert T. Baldwin; treasurer, Ray Harcombe; trustees, E. J. Barber, G. O. Curme, Jr., and T. B. Wagner.

The Club has also elected the following to honorary membership; John J. Abel, F. G. Banting, Emanuel Paterno, Amé Pictet, and Richard Willstätter.

At the same meeting the members approved of a resolution passed by the board of trustees for a campaign to be started to raise $400,000 as an endowment fund for the maintenance of the proposed library corporation of the Chemists' Club, it being understood that the corporation would take over the active management of the present club library.

American Electrochemical Society, Fall Convention. The American Electrochemical Society will hold its Fall Convention in Pittsburgh, Pa., September 19th, 20th, and 21st, to discuss, among other subjects, the contributions of the American Electrochemical Industry to aeronautics. Several hundred chemists, metallurgists, plant executives, and company officials of both the United States and Canada will then convene to discuss recent developments in the Electrochemical Industry.

The program will consist of visits to various industrial plants in the Pittsburgh district, and also technical sessions at which papers on electrochemical subjects will be presented by various prominent men from all over the country. There will be a special symposium on "Contributions of Electrochemistry to Aeronautics," with emphasis given to the light-weight aluminum and magnesium alloys used in airplane construction.

Social features of the meeting will include a smoker, a dinner and dance, and a special program for the ladies of the party.

Pittsburgh, in many ways, can be considered the cradle of the electrochemical industry of the United States. It's the home of aluminum. The bringing of aluminum into the rank of the cheaper metals is looked upon generally as one of the foremost metallurgical achievements of the nineteenth century, and the historian of technology classes the industrial production of aluminum alongside the invention of Bessemer steel. Charles M. Hall, a chemist, took a metallic rarity and made out of it a common metal, and made the entire human race his debtor. The commercial development of the Hall process was begun in 1888 on Smallman Street, Pittsburgh, Pa., and the manufacture of aluminum became a business success at New Kensington, Pa. Since then the progress has been marked, and chemistry has been the pathfinder.

Another sample of Pittsburgh's contribution to electrochemistry is the discovery of silicon carbide (carborundum) by E. G. Acheson. Acheson first produced carborundum in March, 1891, at Monongahela City, Pa., and began its manufacture in a small way. For the first six months his production amounted to about one-fourth pound per day, but the preliminary manufacturing experimentation proving encouraging, a company was organized, and in 1894 industrial operations were transferred to Niagara Falls. In addition to aluminum and carborundum, Pittsburgh is producing chlorine, caustic soda and other sodium

compounds, chromium and graphite, is the center of the iron, steel, coal, and glass industries of the country, and the home of Station KDKA, the pioneer broadcasting station of the world.

The headquarters of the meeting will be the William Penn Hotel, 5th Avenue and William Penn Way, in the downtown business section of Pittsburgh. For those who prefer to stay in the Oakland district, which is the educational center of the city, the Schenley Hotel, Webster Hall, and the Fairfax Hotel will be very convenient. In this district are situated the University of Pittsburgh (new skyscraper building under construction), Mellon Institute of Industrial Research, Carnegie Institute of Technology, Carnegie Library, Bureau of Mines, Forbes Field, the home of the Pirates, Pittsburgh Athletic Association, University Club, Physicians' Building, Research Laboratories of the National Tube Company, and the American Sheet and Tin Plate Company, and many other buildings of cultural, social, and technical institutes.

While Pittsburgh can accommodate a large number of transients, it is suggested that reservations be made as soon as possible. Reservations can be made through Mr. Mark W. Egan, c/o The William Penn Hotel.

Recent Appointments at Mellon Institute. The following appointments have been made at Mellon Institute of Industrial Research, Pittsburgh, Pa., during the current calendar year.

Senior Industrial Fellows: G. J. COX (Ph.D., University of Illinois, 1925) has been appointed senior industrial fellow on the utensil multiple fellowship, which was established three years ago for the purpose of studying the materials used in the construction of cooking utensils; before accepting this position he was associate in physiological chemistry at the University of Illinois. H. B. MELLER (E.M., University of Pittsburgh, 1910) has been appointed to the senior incumbency of the smoke and dust abatement fellowship; the Institute's previous investigations (1911–14, 1923–24) in this field received such wide recognition that the work has been resumed. Mr. Meller was director of this work during 1923–24.

Industrial Fellows: J. D. ALLEY (A.B., Columbia University, 1917) has been appointed to the steel treatment fellowship; he has recently been engaged in a study of cast iron products at the Institute. R. F. BEARD (Ph.D., University of Minnesota, 1928) has been appointed to the carbonated beverage fellowship; before taking his doctorate he worked for several years in the field of cereal chemistry. H. G. BOTSET (B.S., in Chem. Eng., Purdue University, 1922) has been appointed an industrial fellow on the petroleum production multiple fellowship; before coming to the Institute he was engaged in industrial work. MARY L. DODDS (M.S., University of Pittsburgh, 1927) has been appointed an industrial fellow on the utensil multiple fellowship; she was previously engaged in work on surgical supplies at the Institute. A. W. JOHNSON (B.S. in Chem. Eng., University of Pittsburgh, 1925) has been appointed to the rosin oil fellowship; before accepting this fellowship he was instructor in chemical engineering at the University of Pittsburgh. T. R. LECOMPTE (Ph.D., Columbia University, 1927) has been appointed to the hemp paper fellowship recently established for the purpose of studying this phase of paper technology; before his appointment to this fellowship he was engaged at the Institute in a study of fur felt hat manufacture. A. G. LOOMIS (Ph.D., University of California, 1919) has been appointed industrial fellow on the petroleum production multiple fellowship; before coming to the Institute he was a member of the staff of the Bureau of Mines, Pittsburgh. R. R. MCCLURE (M.S., University of Chicago, 1917) has been appointed to the pigment fellowship; he was previously engaged in industrial work. S. U. MCGARY (B.S. in Chem. Eng., University of Texas, 1921) has been appointed an industrial fellow on

the petroleum production multiple fellowship. E. W. MORRISON (Ph.D., Yale University, 1929) has been appointed to the food container fellowship established for the purpose of studying certain phases of the manufacture of viscose sausage casings; before receiving his doctorate he had been engaged in industrial work in bacteriology. BEAUREGARD PERKINS, JR. (B.A., B.S., Tulane University, 1916), has been appointed an industrial fellow on the petroleum production multiple fellowship; before coming to the Institute he was assistant professor of physics at Louisiana State University. P. F. SIEGRIST (B. Cer.E., Ohio State University, 1927) has been appointed an industrial fellow on the Portland cement multiple fellowship; before coming to Pittsburgh he was engaged in industrial work. J. T. STEARN (D.Sc., Federal Polytechnic Institute, Zurich, 1923) has been appointed an industrial fellow on the scales multiple fellowship; he was previously in industrial work. L. W. VOLLMER (B.S., Pennsylvania State College, 1926) has been appointed an industrial fellow on the petroleum production multiple fellowship; he was previously engaged at the Institute in work on cast iron technology. V. S. WRENN (Ph.B., Yale University, 1918) has been appointed an industrial fellow on the dental multiple fellowship; before coming to the Institute he was a bacteriologist in the Veterans' Bureau at Cincinnati. J. L. YOUNG (Ph.D., University of Pittsburgh, 1926) has been appointed to the heating fellowship; he was previously engaged in research on pyrometry at the Institute.

The following persons have been appointed fellowship assistants: J. R. ADAMS (M.S., Carnegie Institute of Technology, 1929), petroleum refining; C. N. BOWERS (B.S. in Mech. Eng., University of Pittsburgh, 1929), petroleum production; S. M. COOPER (B.S., University of Pittsburgh, 1929), petroleum refining; F. E. GALLAGHER, petroleum production; DOROTHY HAMILTON (B.S., Trinity College, Washington, D. C., 1927), smoke abatement; S. R. HATHAWAY (A.M., Ohio State University, 1928), sleep; ELEANOR M. JONES (A.B., Goucher College, 1929), smoke abatement; J. A. SATOSKY (B.S., Pennsylvania State College, 1929), carbon black; W. F. SPEER (B.S. in Chem. Eng., University of Pittsburgh, 1928), edible gelatin; MARY E. WARGA (M.S., University of Pittsburgh, 1928), smoke abatement; HELEN B. WIGMAN (B.S., University of Pittsburgh, 1928), utensil; C. G. ZUR HORST (Met.E., University of Pittsburgh, 1924), petroleum production.

International Physiological Congress to Be Held at Boston in August. American physiologists will be the hosts of one of the most distinguished groups of European scientists who have ever come to this country, when the Thirteenth International Physiological Congress meets at Boston from the nineteenth to the twenty-third of this month. Word has been received from England that 300 reservations are being held on the liner Minnekahda, which sails from London on August 9th and from Boulogne on August 10th, reaching Boston the day before the opening of the Congress. In addition to the large block of foreign delegates who will come on this ship there will undoubtedly be many others who will sail at an earlier date, and a considerable number of European physiologists already visiting in this country. The number of members expected from the United States, Canada, and Mexico has not yet been estimated, but it is probable that the total attendance at the Congress will be well over the thousand mark.

The International Physiological Congresses have been important events in the scientific world for more than a generation. The first one was held at Basel, Switzerland, in 1889, and since then the meetings have taken place regularly at three-year intervals, with the exception of an interruption due to the war. The last one was held in Stockholm in 1926. Other meeting places have been Liège, Bern, Cambridge, Turin, Brussels, Heidelberg, Vienna, Groningen, Paris, and Edinburgh.—*Science Service*

Recent Books

General Science for Reviews. W. DEAN PULVERMACHER, M.A., LL.B., Chairman, General Science Department, Jamaica High School, New York City, and CHARLES H. VOSBURGH, M.A., Principal, Jamaica High School. Globe Book Company, New York City, 1929. ii + 125 pp. 68 illustrations. 12.5 × 18.5 cm. $0.50.

This little manual, prepared for review purposes, includes in fifteen chapters essential topics in general science suited to pupils in the intermediate schools. The topics are presented in simple language and are illustrated by simple, well-drawn figures. Appended to most of the chapters is a series of questions designed to exercise the thinking powers of the pupil. Key experiments are made the basis for much of the work. Chemistry, physics, astronomy, and various phases of biology are represented by chapters or exercises under chapter headings. To the reviewer it seems that somewhat too much emphasis has been placed upon the biologic aspect, but perhaps a chemistry teacher is hardly a fair critic on this point.

The sixteenth chapter deals with some of the newer types of examinations, while the remainder of the book presents a number of recent examinations in general science given, supposedly, by the Board of Regents. There are no appendices or index.

Teachers of general science who desire a small manual for use in reviewing the elementary phases of the subject will do well to examine this little volume.

C. H. STONE

ENGLISH HIGH SCHOOL
BOSTON, MASSACHUSETTS

Elements of Physical Chemistry. JAMES M. BELL, Head of the Department of Chemistry, University of North Carolina, and PAUL M. GROSS, Head of the Department of Chemistry, Duke University. First edition. Longmans, Green and Co., New York, 1929. xiii + 466 pp. 88 figures. 13 × 20 cm. $3.75.

In the preparation of the book the authors "have had in mind the college student who takes up the study of physical chemistry after the usual courses in general chemistry, analytical chemistry, and organic chemistry, and who has had a course in general physics and preferably in the calculus. * * * * The book is frankly elementary, for it is designed to accompany a year's course of two lectures a week." Fourteen laboratory experiments requiring three laboratory hours each week are included.

The text should be a teachable one, appealing to the student, for it is, in general, clearly written, and it endeavors to present a logical outline of the general principles of physical chemistry. Since the chapter on thermodynamics immediately follows the discussion of gases, its principles are quite naturally and logically utilized in the discussion of the vapor pressure of liquids as well as in later work. The inevitable mathematics is so introduced that it is no more terrifying to the student than the same simple algebra and calculus in a mathematics course would be. Much material of specialized interest and most of that of solely historical interest is omitted; part of the matter will be a review for those students who have studied some of the general principles in their general and analytical chemistry courses. For such classes, teachers would probably wish to supplement the text with additional material.

The parts of the text dealing with the use of thermodynamic equations in calculations are not up to the standard of the

rest of the book. In the chapter on thermochemistry the authors consider heat *evolved* as positive, and in the thermodynamic derivations they use heat *absorbed* as positive, but nowhere is this change in convention explicitly stated. The student who wishes to correlate the day's assignment with his previous work will therefore find on page 78 that heat at constant pressure equals heat at constant volume *minus* the work done, and on page 304 that heat at constant pressure equals heat at constant volume *plus* the work done. If he substitutes the data for the dissociation of nitrogen tetroxide, given on page 306, in the integrated van't Hoff equation on page 305, he will not check the authors' calculation, for they, without explanation, use Q in this example as heat *evolved*, though in the next example Q is used as heat *absorbed*. He will find the same uncertainty on pages 372 and 373. The good student will desire to have conventions suggested which enable him to calculate, from a given set of data, the direction as well as the magnitude flow.

The book is free from typographical errors. Among the oversights, however, is the discussion (page 352 et seq.) introducing "Henry's law," although the law is left undefined. The use of the logarithm tables in the appendix would be facilitated if the parts of a table were printed facing each other, and not on both sides of a leaf. Some teachers would prefer to have included in the paragraph on the methods of expressing solution concentration, the expression in terms of mols per 1000 grams of solvent; others would qualify the statements on the conservation of mass in the light of modern physics. The student might well be told that the "triple point" for water is not exactly at 0°C. and the reasons why it is not. These latter criticisms are of secondary importance. The teacher who has a limited time in which to introduce a class to some of the principles of physical chemistry should examine the book.

L. E. STEINER

OBERLIN COLLEGE
OBERLIN, OHIO

Practical Chemistry by Micro-Methods. EGERTON CHARLES GREY, D.Sc., F.I.C. (Lond.), M.R.C.S., Professor of Chemistry, Government Medical School, Cairo. W. Heffer and Sons, Ltd., Cambridge, 1925. ix + 124 pp. 16 illustrations. 13.5 × 21.5 cm. 4s. 6d. net.

The purpose of the book may best be judged by quotations from the preface: "It must be evident to many that the time has come for a change in some of the methods of teaching practical chemistry. Classes seem to get larger every year . . . many experiments which could once be performed by each individual must perforce be omitted, and there is a tendency to meet the situation by adapting the practical course to the convenience of the laboratory rather than to the individual needs of the students. . . The method of practical microchemistry is that of working with minute quantities of material, specks of solids, drops of liquids. With this method the difficulties which would hamper many a laboratory will be found to vanish. . . There is nothing which at present is done by students with large apparatus that cannot be done with the micro-method, but there is much that can be done with small apparatus that is a sheer waste when done on the larger scale. . . A student's whole outfit may be put upon a tea-tray, and with all his laboratory thus at hand the student may sit down to his work with consequent sparing of fatigue to himself and to his teacher. . . The methods of microchemistry are exceedingly rapid. . . With this sparing of time it follows that much more work can be got into the working hours. . . The economy also in energy and in expense is enormous, with the result that it is possible to cover a much broader field of study. . . . This book is intended for schools or for the earlier part of a university course and it covers the practical work required by the conjoint boards of the Royal College of Physicians and Surgeons. While describing the methods of microchemistry, it indicates also how a practical course may be broadened to include exercise in

elementary physical chemistry, qualitative analysis, volumetric analysis, and a brief introduction to organic chemistry is given. . ."

The book is well written and the author has accomplished his purpose, but it is doubtful if it will meet the requirements of students in this country.

However, it should be read by every teacher of chemistry, because it contains an idea which may revolutionize laboratory instruction in our high schools, colleges, and universities. The use of the microchemical methods, particularly for analysis, is rapidly increasing. Is the time coming when we can walk through a laboratory of organic chemistry in one of our large universities and see the students sitting at desks making small amounts of their preparations quickly and studying the properties of substances with completeness and accuracy? There would be almost no noise, no odor, and any danger would be reduced to a minimum. More laboratory work could be done better in half the time now consumed without tiring the student. The advantages gained by this factor alone would be numerous.

The author has not emphasized sufficiently the improved technic which follows training in the microchemical methods. Students trained from the beginning in microchemistry would be much better fitted for the study of medicine, biology, and related sciences. "Chemists" trained in this way would acquire a splendid laboratory technic. As the laboratory work would be more complete a better knowledge of the practical side of chemistry would be obtained.

As organic chemists throughout the world are adopting the methods of quantitative organic microanalysis developed largely in the Medical-Chemical Institute of the University in Graz the teachers of chemistry may adopt, in part at least, this idea from Cairo.

RALPH T. K. CORNWELL

HYGIENIC LABORATORY
U. S. PUBLIC HEALTH SERVICE
WASHINGTON, D. C.

Inorganic Chemistry for Colleges. WILLIAM FOSTER, Ph.D., Professor of Chemistry, Princeton University. First edition. D. Van Nostrand Co., New York City, 1929. viii + 837 pp. 212 figures. 13.5 × 21.5 cm. $3.90.

This book is designed for college students who have had a high-school course in general chemistry. It is divided into four parts as follows: *Part I* (112 pages). Terminology, the laws of chemical changes, symbols, formulas, equations, the gas laws, crystal structure, radioactivity, atomic numbers, classification of the elements, and the modern theory on the structure of matter.

Part II (386 pages). The non-metals in general, including also a chapter on solutions, the ionic theory, oxidation and reduction from an electronic standpoint, and colloidal chemistry. While carbon is discussed in this section organic compounds proper are left for *Part IV*.

Part III (221 pages). The Metals. Besides a discussion of the metals and their properties this section includes a chapter on electrochemistry.

Part IV (71 pages). This is called the Supplementary Part and is devoted entirely to organic compounds. At the end of this section there is an excellent list of 144 problems with answers. These illustrate principles taken up in the entire book.

The appendix contains the usual tables and also a table of logarithms.

Many photographs of men, including Arrhenius, Mendeléeff, and Richards, are placed throughout the book.

At the end of each chapter a set of questions is given, varying in number from 15 to 25 and thoroughly covering the material taken up in the discussion.

This book does not leave out any of the essential facts usually taken up in elementary chemistry texts. It passes over some of the details given in these, but the essential difference is that the subject matter is developed more thoroughly. For example: such subjects as catalysis, crystal structure, and the more common

rare gases are given rather full treatment.

One novel feature worthy of commendation is that radioactivity is taken up before atomic structure.

On the whole the book is well arranged and subject matter placed in its logical position. An apparent digression from this is that the chapter on electrochemistry is placed between the tin and arsenic groups in the discussion of metals.

It is noted also that while electronic structure is taken up before the chapter on oxygen, oxidation receives only its usual discussion under "oxygen" and its more full meaning is given in a latter part.

The book is nicely bound and printed in large clear type with only a very small amount of material in small type.

From the standpoint of both the student and teacher this book should be well received. It is well arranged for study and assignment purposes.

CHARLES E. WHITE

UNIVERSITY OF MARYLAND
COLLEGE PARK, MD.

The Foundations of the Theory of Dilute Solutions. Papers on Osmotic Pressure by J. H. VAN'T HOFF and on Electrolytic Dissociation by SVANTE ARRHENIUS. 1887. Alembic Club Reprint, No. 19. Edinburgh: Published by the Alembic Club. Edinburgh agents: Oliver and Boyd, Tweeddale Court. London agents: Gurney and Jackson, 33 Paternoster Row, 1929. 67 pages. 12.3 × 18.3 cm. Price, $0.65, post free.

This latest number of the Alembic Club Reprints contains an English translation of two papers, one by van't Hoff on "The Rôle of Osmotic Pressure in the Analogy between Solutions and Gases," the other by Arrhenius "On the Dissociation of Substances in Aqueous Solution," both of which originally appeared in 1887 in the first volume of the *Zeitschrift für physikalische Chemie*. Arrhenius had previously published in the *Proceedings of the Swedish Academy of Sciences* for 1883 a paper on the conductivity of electrolytes and van't Hoff in 1885 had published in the same *Proceedings* a paper on chemical equilibrium in dilute gaseous mixtures and in dilute solutions. Those two first papers supplemented each other and laid the ground-work. But it was only after the appearance of the papers which are printed in this volume that the theories of electrolytic dissociation and osmotic pressure began to bear fruit. They still continue to bear—abundantly.

This slender book is easy and interesting reading. It shows the origins of some of the most significant of physico-chemical theories and shows them in a manner which makes it easy to understand that the theories soon found general acceptance and wide application in experimentation and research. It is curious—or perhaps it is not so curious—that these original documents seem more sincere, more apprehensible, more convincing than the expositions of the same theories which are printed in the textbooks. Textbooks are commonly dogmatic, but the man who has discovered the generalization necessarily puts it forward in a persuasive manner with an eye to the arraying of the evidence.

The Alembic Club Reprints ought to be accessible to all students of chemistry. Many students will find that they can get from the masters a quicker and a clearer understanding of the puzzling things in their science than they can from the textbooks. And, having seen the story in its growth, they will have the story for good. An understanding of origins is a useful aid toward the understanding of the present status of a science. But it is important for another reason. The present status changes. The origins do not.

We wish more power to the Alembic Club, and we wish for more of its valuable reprints.

TENNEY L. DAVIS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
CAMBRIDGE, MASSACHUSETTS

X-Rays in Industry. Eastman Kodak Company, Rochester, New York, 1929. 60 pp. Illustrated. 14 × 21.5 cm. Free upon request.

X-ray photography is practically identical in the public mind with certain phases of medical and dental science. But such a valuable tool would not readily confine itself to the needs of the anatomical sciences in this day of alertness to new uses for existing processes. X-rays are increasingly being used to determine the internal structure of inanimate objects.

Steel castings, aluminum castings, metal radio transmission tubes, a variety of other metal objects, and even trees and telegraph poles, have been subjected to x-ray examination. Such examination has already become standard practice in some factories. The principal work along these lines has been done in the Watertown Arsenal and the Massachusetts Institute of Technology in the United States, and in the Woolwich Arsenal in England.

This information, as part of a brief survey of the theory and use of x-rays in industry, is included in this booklet just prepared by the Eastman Kodak Company. The publication, which will be sent to interested persons, has the intention of suggesting some of the industrial applications of x-rays in inspecting the internal construction of opaque materials.

This booklet should stimulate manufacturers to visualize many applications of radiography peculiar to their own businesses.

Organic Syntheses. The Board of Editors of *"Organic Syntheses"* (an annual publication of satisfactory methods for the preparation of organic chemicals) has decided to collect, revise, and rearrange the preparations in the first nine volumes in such a way as to make them more suitable for general use in synthetic organic chemistry. All of these preparations are to be published in a single comprehensive volume to be designated as the "Collective Volume—Revision of Volumes I–IX."

In this work of revision we would greatly appreciate suggestions in the way of corrections, difficulties in checking, new and improved methods, etc. Address Henry Gilman, Iowa State College, Ames, Iowa, U. S. A.

Health Hazards from Gases. The Treasury Department has issued, as *Public Health Bulletin* **185,** a 56-page pamphlet on "Physiological Response Attending Exposure to Vapors of Methyl Chloride, Ethyl Bromide, and Ethyl Chloride," prepared from data contained in the report of the Bureau of Mines to the National Research Council and the Dow Chemical Co., by R. R. Sayers, Surgeon, United States Public Health Service, and Chief Surgeon, Bureau of Mines; W. P. Yant, Supervising Chemist, B. G. H. Thomas, Associate Pathologist, and L. B. Berger, Laboratory Assistant, Bureau of Mines.

Copies of the bulletin may be procured from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 15 cents.—*News Ed., Ind. Eng. Chem.*, **7,** 9 (June 10, 1929).

"Chemistry and Physics" is the title of a pamphlet (H. M. Stationery Office, 14 pp., 2d.) compiled by arrangement between the Incorporated Association of Head Masters of Public Secondary Schools and the Ministry of Labor. Its purpose is to afford useful and authoritative information to parents, teachers, and all who are concerned in advising boys from public secondary schools on the choice of a suitable career. Further pamphlets on other professions and occupations are in course of preparation, and will be published at short intervals. The series is called "Choice of Career Series (Secondary Schools)," of which the present is No. 1.—*Chem. Age,* **20,** 568 (June 15, 1929).

Table of Common Hazardous Chemicals. The National Fire Protection Association, 60 Batterymarch St., Boston, Mass., has issued a booklet entitled "Table of Common Hazardous Chemicals," prepared by the Committee on Hazardous Chemicals and Explosives of the AMERI-

CAN CHEMICAL SOCIETY and the National Fire Protection Association. The committee had the coöperation of committees of the Manufacturing Chemists' Association and the National Fertilizer Association, and is now considering the question of additions to the table. The booklet consists of 12 pages, sells at 15 cents per copy, and presents information under the following headings: name of chemical, usual shipping container, fire hazard, life hazard, storage, and remarks. —*News Ed., Ind. Eng. Chem.*, **7**, 4 (Mar. 20, 1929).

Per Capita Costs in City Schools, 1927–28. F. M. PHILLIPS, Chief, Division of Statistics. *Department of the Interior*, Statistical Circular No. 12. U. S. Govt. Printing Office, Washington, D. C., 1929. 11 pp. 14.5 × 23 cm. $0.05.

Illiteracy in the Several Countries of the World. JAMES F. ABEL, Specialist in Foreign Education, and NORMAN J. BOND, Principal statistical assistant. *Department of the Interior, Bureau of Education Bulletin*, No. 4. U. S. Govt. Printing Office, Washington, D. C., 1929. 68 pp. 14.5 × 23 cm. $0.15.

Educational Boards and Foundations, 1926–28. HENRY R. EVANS, Editorial Division, Bureau of Education. *Department of the Interior, Bulletin* No. 9. U. S. Govt. Printing Office, Washington, D. C., 1929. 12 pp. $0.05.

Higher Education, Biennial Survey 1926–28. ARTHUR J. KLEIN, Chief, Division of Higher Education, Bureau of Education. *Department of the Interior, Bulletin* No. 11. U. S. Govt. Printing Office, Washington, D. C., 1929. 42 pp. $0.10.

Report on Higgins' Book "A Comparative View of the Phlogistic and Antiphlogistic Doctrines." Prof. J. Reilly and D. T. MacSweeney give an account, in the *Proceedings of the Royal Dublin Society* for January, No. 15, of the work of Willaim Higgins, whose book, published in 1789, "A Comparative View of the Phlogistic and Antiphlogistic Doctrines," contains some interesting speculations on chemical combination. The work is the first defense of the new views of Lavoisier in the English language and was written in answer to Kirwan's "Essay on Phlogiston." Higgins' work, according to Reilly and MacSweeney, contained the fundamental germs of the chemical atomic theory, and had it not been neglected it would have led to much that Dalton afterward put forward. It is to the genius and industry of Dalton, and the encouragement and friendly criticism of his contemporaries, that the main credit for the establishment of the theory must be ascribed. Higgins' work (which is based on experiment and is by no means purely speculative) is particularly interesting in its attempt to represent affinities as well as combining proportions, a side of the subject which was, perhaps wisely, entirely neglected by Dalton. The formulas used by Higgins are also more related to modern formulas than were those of Dalton.—*Nature* (London), **123**, 356 (Mar. 9, 1929).

It is idle to say that the most important subjects affecting social welfare are too abstruse for adolescent minds, when pupils in our grammar and high schools are presented daily with situations, national and international, which call for a knowledge of history and geography, science and economics, political economy and sociology. Some problems of trade and transportation, of capital and labor, of political policy and international relations must be faced in the modern school. I mention these in particular because they are the most perplexing of all the problems that the teacher meets. They cannot be ignored; they must be honestly and impartially treated.—JAMES E. RUSSELL